SAE JOURNAL

Summer Meeting Issue

JULY
1953

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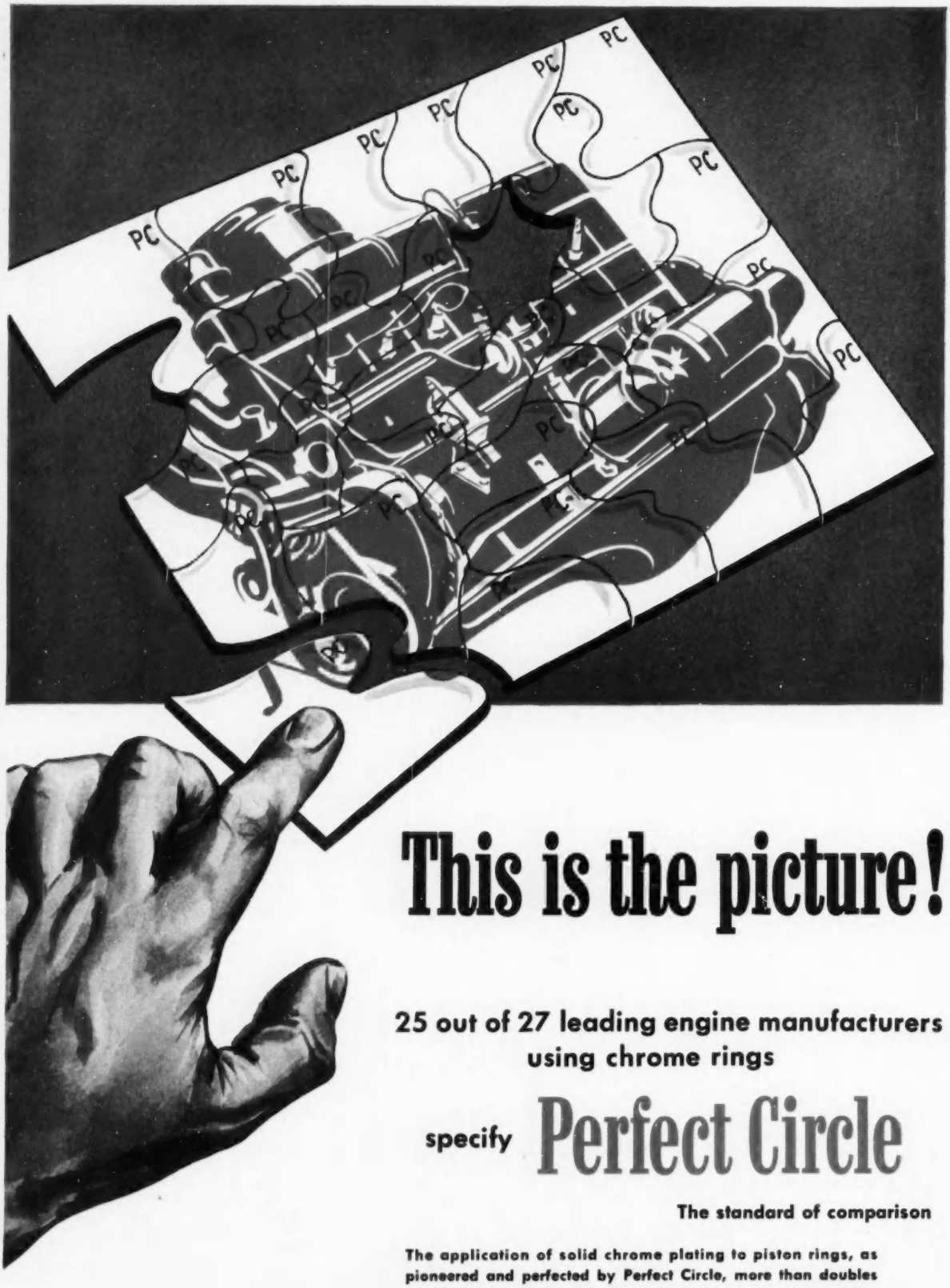

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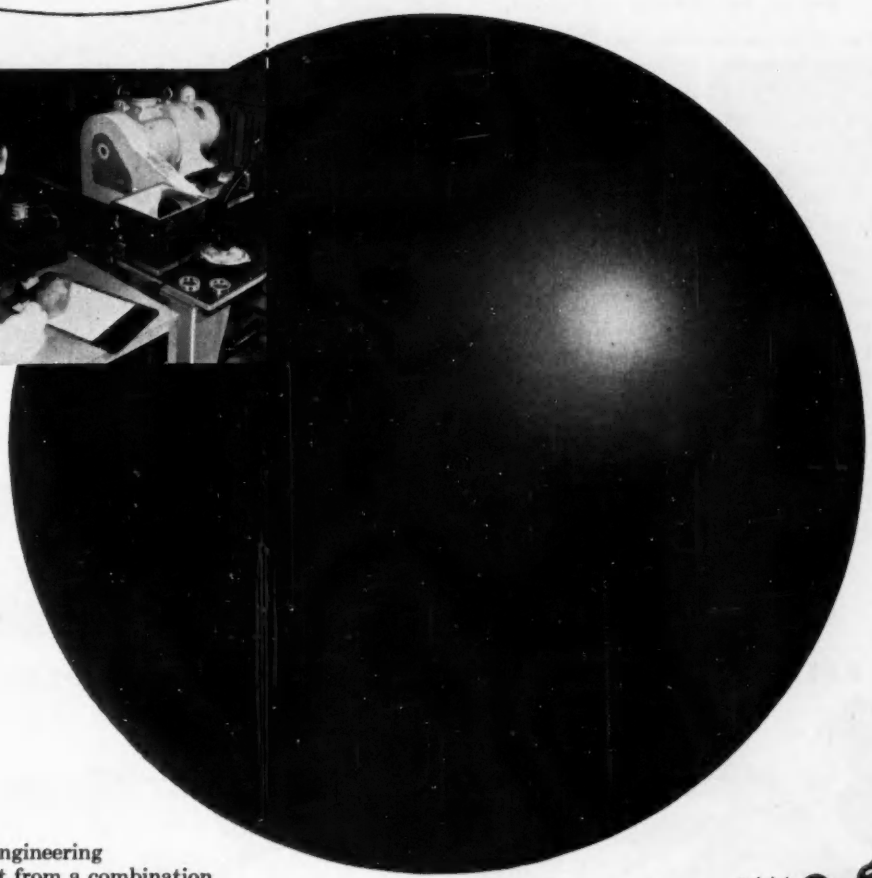

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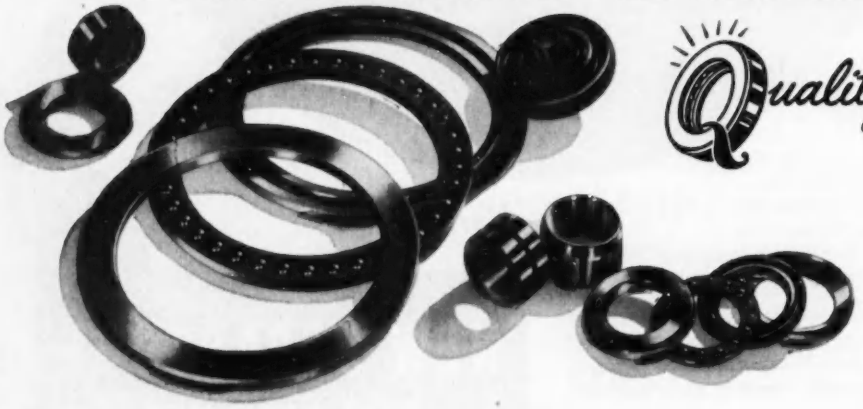

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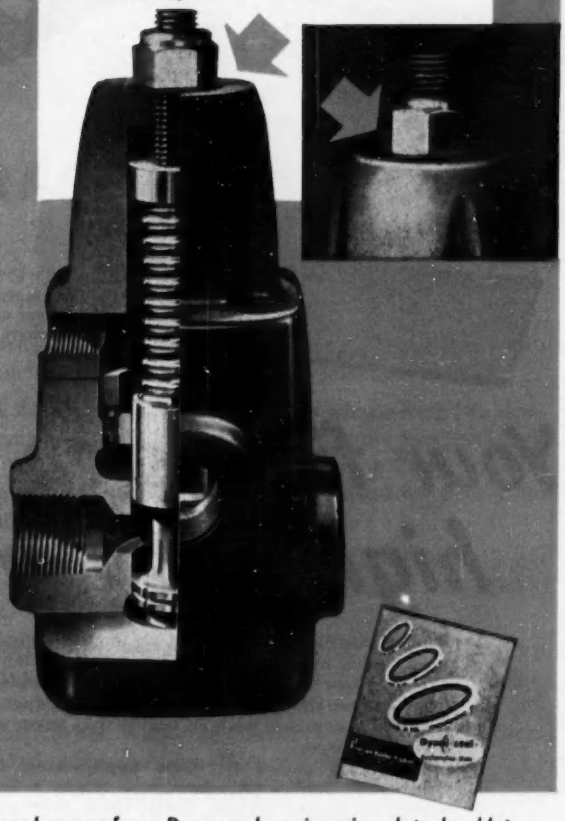

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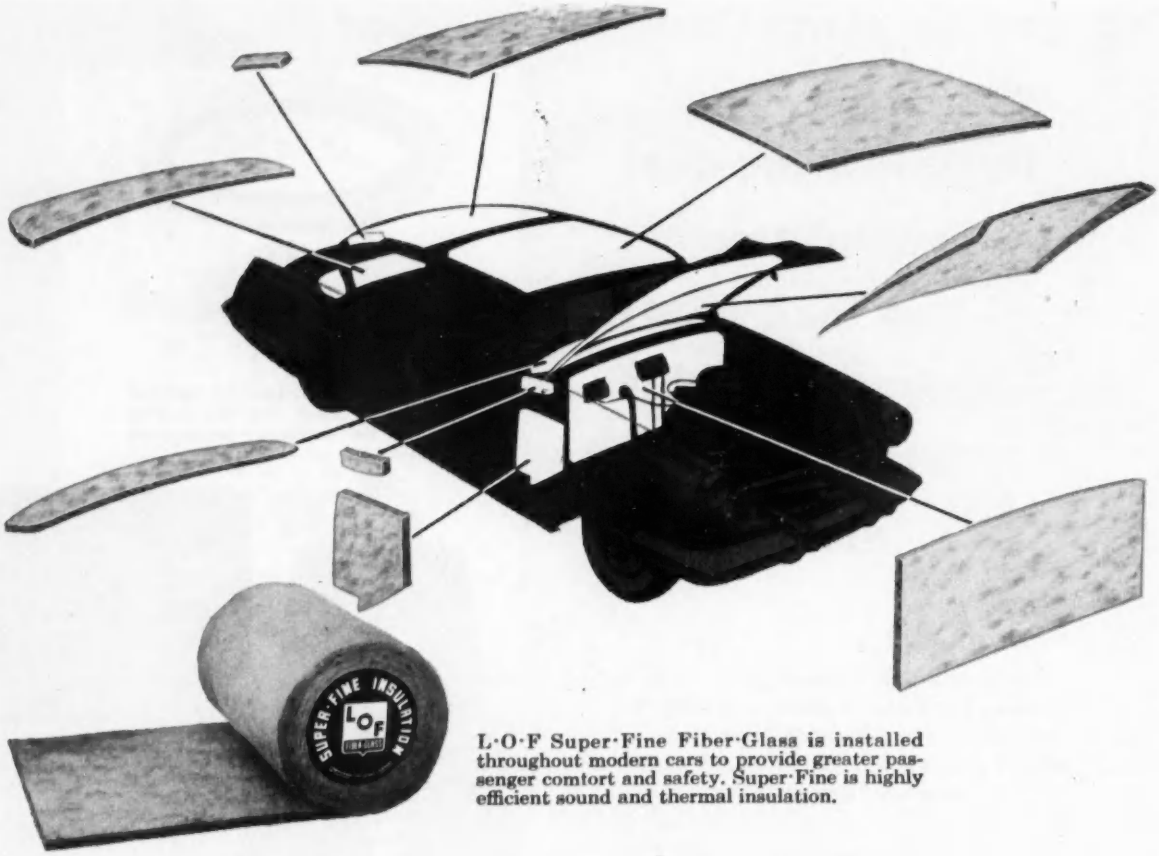

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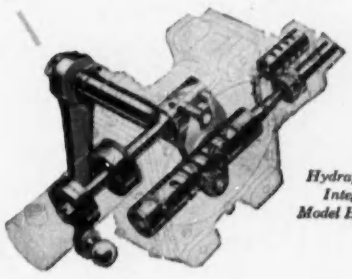

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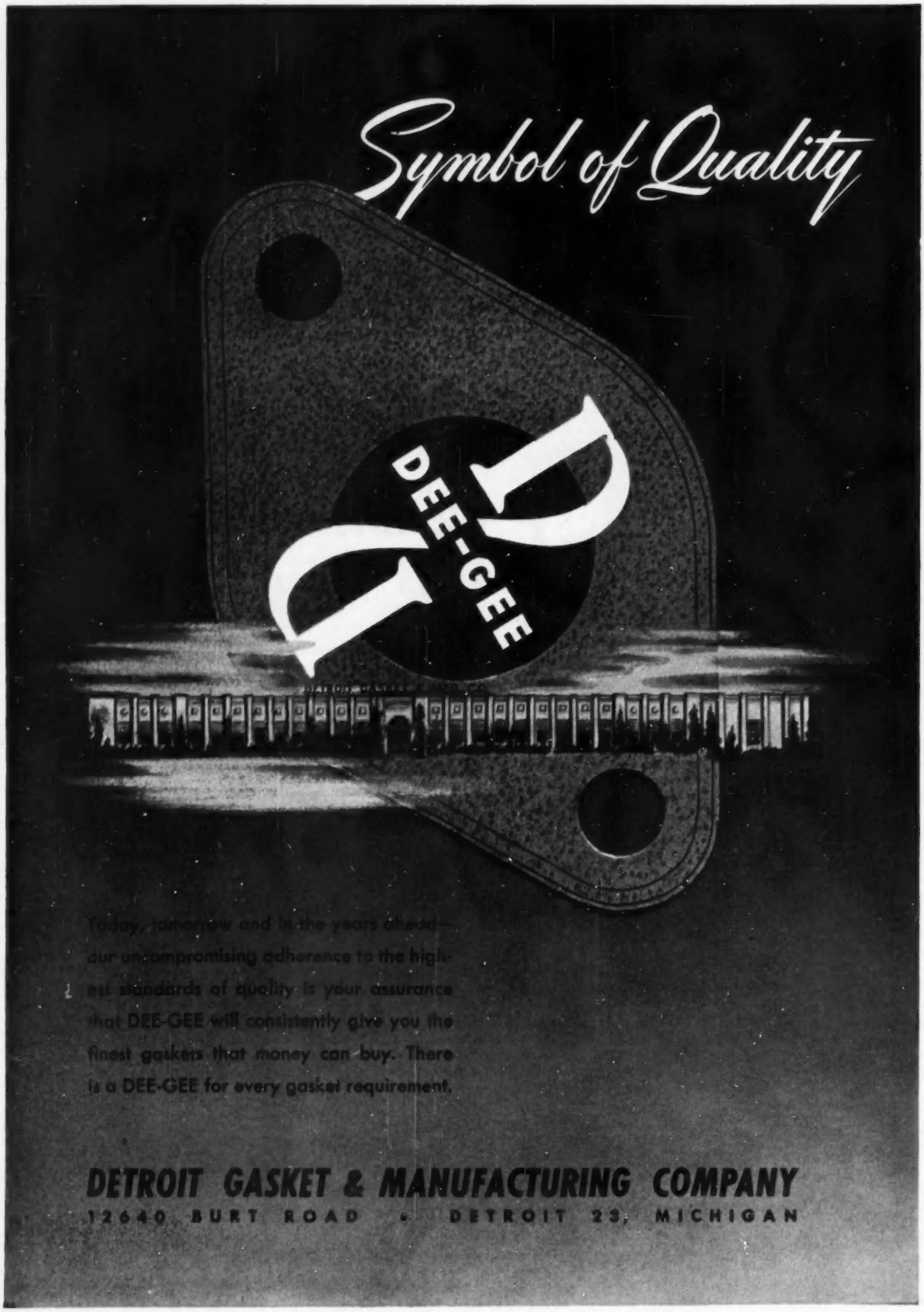
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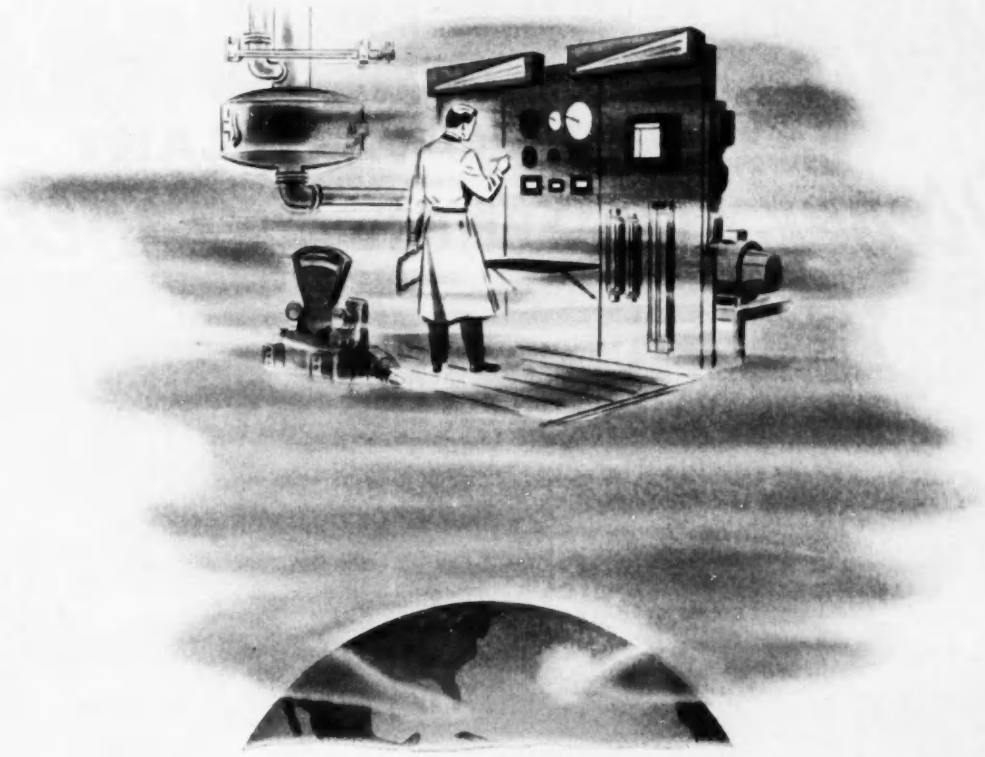

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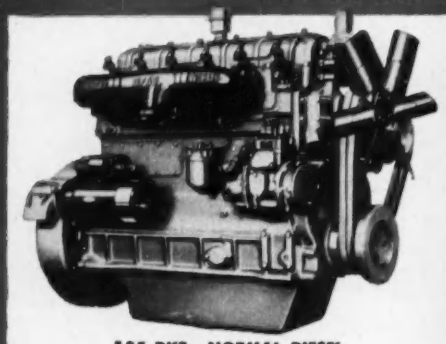

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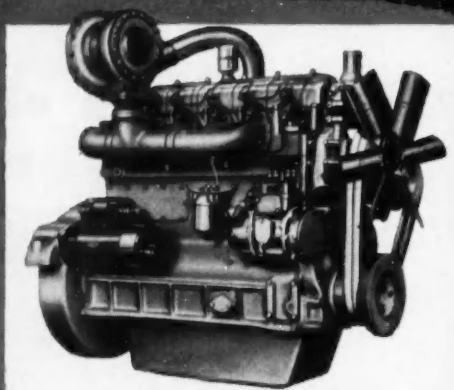

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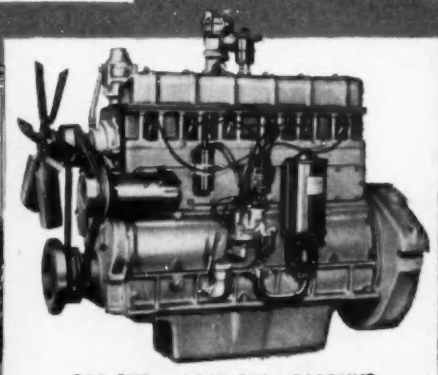

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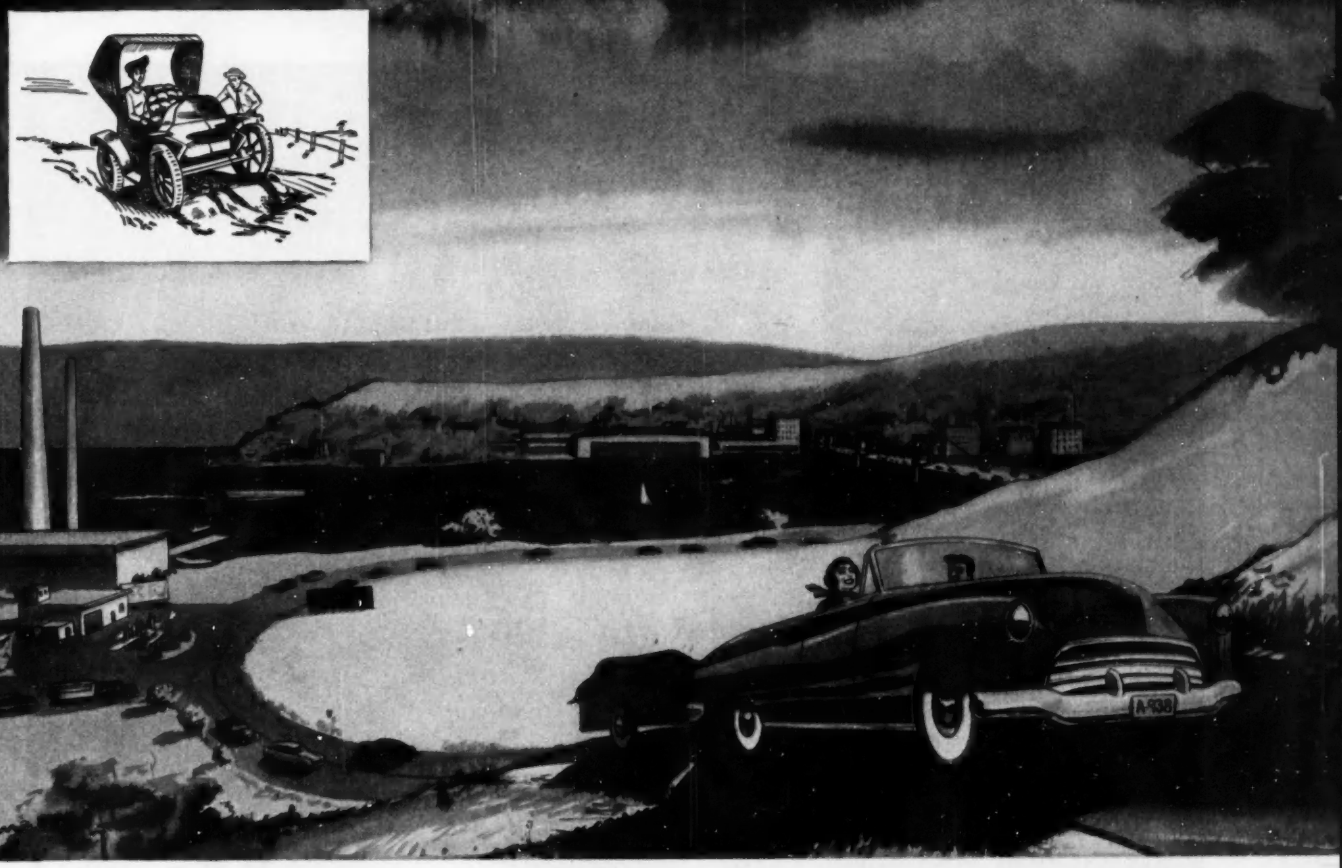

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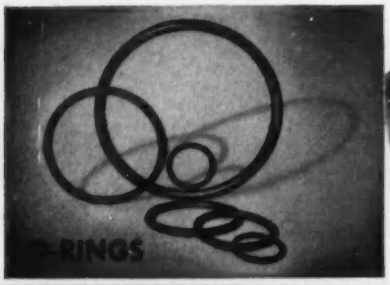

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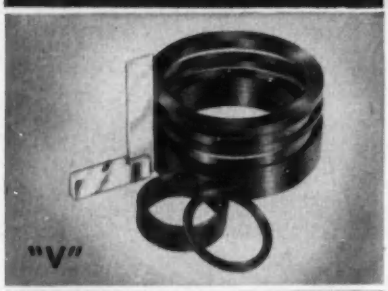

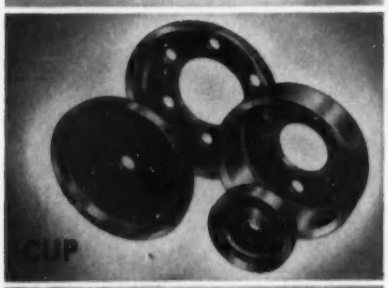

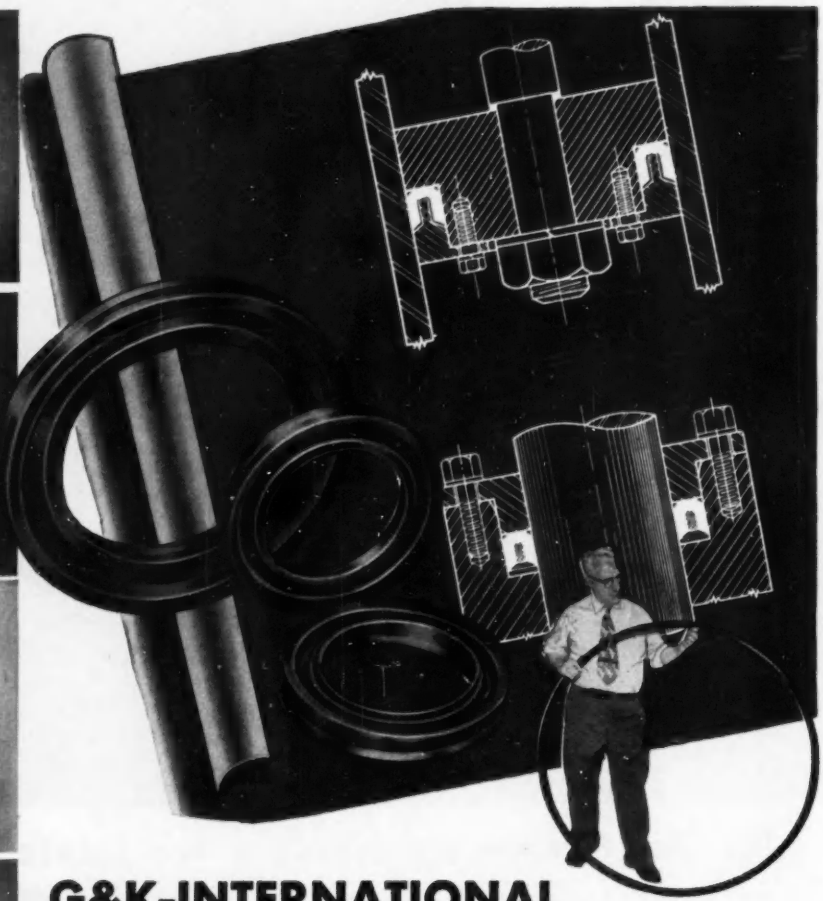

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For the Sake of Argument

On Receiving Criticism . . .

By Norman G. Shidle

A very wise man once said that a fellow doesn't deserve any particular credit for accepting just criticism with patience. It's the man who can be patient with criticism of his good deeds, he said, that deserves stars in his crown.*

This particular wise man was speaking from the depths of his own heart and his own experience. He was noted for his strength and his forthrightness as much as for his wisdom. He is remembered for his few failures as much as for his many successes. He was usually right, but when he was wrong, he was absolutely wrong. Keeping his wisdom atop his emotions was a problem throughout his life.

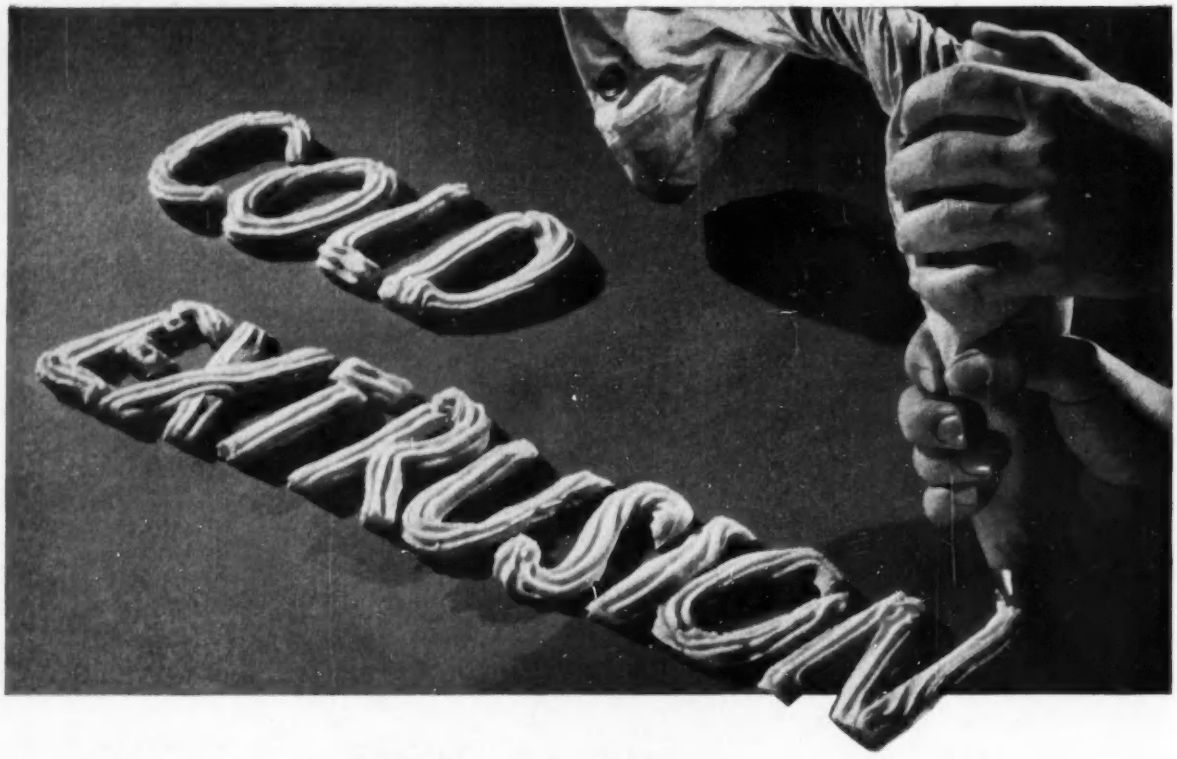
So, when he made this crack about patience in the face of criticism, he knew whereof he spoke.

Receiving criticism with patience, of course, is one thing. *Accepting* it is another. And the distinction is important. To *accept* a truly unjust criticism doesn't make much sense—whether it be accepted patiently or impatiently. But to react defensively to the mere presence of criticism—just or unjust—butters few parsnips.

The advantages of *receiving* criticism with patience are several. For one thing, it makes unnecessary emotional, snap judgment about the criticism's justness or unjustness. It gives the receiver time to decide thoughtfully whether to accept or reject the particular attack. Besides, it enables him to glide instead of joggle through hundreds of everyday situations.

Criticism is one thing that most of us feel is more blessed to give than to receive. It's amazing how often we turn out to be wrong.

* These weren't his exact words, but they constitute a pretty fair modern translation of an ancient text. If anybody is interested in the exact original, we'll be glad to supply it.



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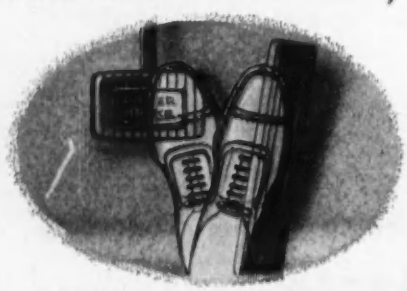
Dealers are enthusiastic because with the Bendix Low Pedal Power Brake it is now easy to demonstrate added braking power and safety. Service managers are happy because of its trouble-free performance and, best of all, new car buyers realize that with today's trend toward "power" operation, a car equipped with a Bendix Low Pedal Power Brake offers the ultimate in braking efficiency.

Remember, too, this new low pedal power brake is the product of Bendix, world's largest producer of power brakes and leader in braking developments since the earliest days of the industry. That's why if you are contemplating power braking it will pay to "Sign Up" with Bendix for the greatest improvement in braking since four wheel brakes. *REG. U.S. PAT. OFF.

NOW *Stopping* IS AS EASY AS *accelerating*



It is no longer necessary to lift the foot and exert leg power pressure to bring your car to a stop. With the Bendix Low Pedal Power Brake on about the same level as the accelerator, an easy ankle movement, much like working the accelerator, is all the physical effort required for braking. And by merely pivoting the foot on the heel, shifts from "go" to "stop" controls are made in far less time.

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THE MOST TRUSTED NAME IN BRAKING

Sun-Sand-Sea Site Suits Summer Session

AUTOMOTIVE engineering issues played against the marine surroundings of Atlantic City again proved a happy combination, as more than 1600 participated in technical exchanges and oceanside frolics at the '53 SAE Summer Meeting, June 7–12.

Engineeringwise, vehicle and human preservation against the terrible tempests of atomic attack and subzero cold stirred up the most interest. Funwise, the World Tour Varieties, skippered by Admiral and Mrs. Bob Steeneck, walked off with top honors.

But all through the week, provocative technical fare and the menu of social and sports diversions catered to a broad variety of interests and tastes. Discussions started at round tables, panels, and

Continued on page 56

Heat's on Car Makers for

JUST as passenger-car makers have responded to the cry for safer, smoother riding, more economical vehicles, so they are now preparing to meet growing public demand for air conditioning in cars. Some companies, in fact, are ready to offer this equipment as an accessory this year. Others are not. But whether ready or not, all car makers have one thing in common—they've all either faced, or will face, similar problems. For example, each will have to decide:

- How fast the market can be developed.
- Whether to make or buy various system parts.
- What kind of performance to design into the system . . . and where to put component parts.
- Where to install the systems . . . on the final assembly line, off the line, or in dealer service shops.

One of the first things that will have to be decided is: How broad is the market? How fast can it be developed? This is extremely important. That's because the answer or estimate made will have an important bearing on such things as manufacturing space to be allowed, type of tooling to be provided, and the appropriation for advertising and sales promotion.

The general picture can be summed up this way. Approximately 3000 cars were equipped with car cooling before World War II . . . with about 7500 more getting it since then. Most of these units were purchased by car owners living in Southwestern states where temperatures range above 100 F a considerable part of the time. But it must be remembered they were sold without benefit of na-

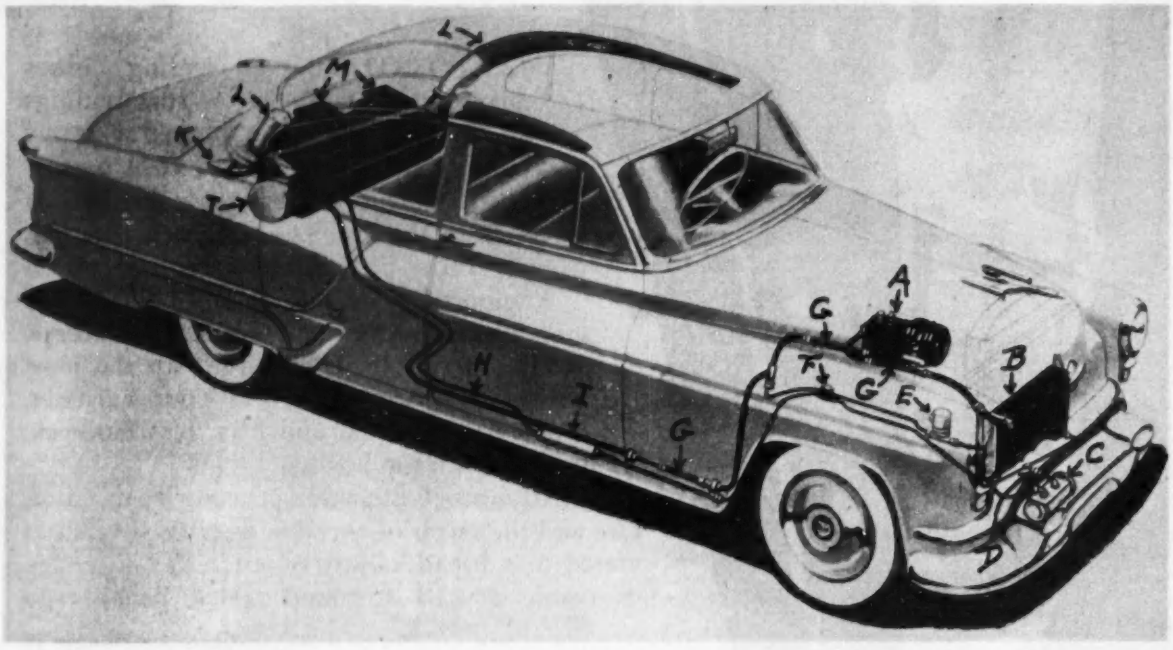


Fig. 1—It takes a lot of thought and ingenuity to find suitable locations for all the bits and pieces in an automobile air conditioning system. It's important that the various component parts not affect the utility and performance of the car. This schematic drawing shows how one passenger-car maker has solved the problem. The lettered parts are:

A—Compressor
B—Condenser
C—Receiver
D—Receiver Check Valve
E—Metering Solenoid
F—Liquid Line Sight Glass
G—Flexible Connectors
H—Refrigerant Lines
I—Liquid Line Dehydrator and Filter
J—Evaporator and Blower Assembly
K—Fresh Air Intake
L—Discharge Ducts and Air Distribution Grilles
M—Return Air Grilles

Cars that Beat the Heat!

M. W. Baker and D. C. McCoy, Frigidaire Division, General Motors Corp.
H. V. Joyce, Ford Motor Co.
P. J. Kent, Chrysler Corp.

Based on papers, "Your Car Can Beat the Heat," by Baker and McCoy; "Production and Service Aspects of Automotive Air Conditioning," by Joyce; and "Automobile Passenger Compartment Cooling from the Vehicle Manufacturer's Viewpoint," by Kent, presented at SAE National Passenger-Car, Body, and Materials Meeting, Detroit, March 5, 1953.

tional advertising or other strong promotion.

A far better clue to the market for car air conditioning is obtained by noting where home air conditioning units are popular. And it is no secret that they sell best in and around New York City! Thus, it is considered fair to say that there is a good demand for car cooling in practically all parts of the United States.

As for the export field, much of our automobile market lies in countries which are quite warm a good part of the year. What's more, the people in these lands who buy U. S. cars are relatively wealthier than U. S. buyers. Therefore, there appears to be a fairly good export market for car cooling, too.

Cooling in One Out of Every Ten New Cars

But how fast can this market be developed? It's always dangerous to predict. However, barring all out war or depression, it is believed that within 5 or 10 years one out of every ten new cars will be equipped with air conditioning!

How a manufacturer estimates his market will, of course, affect his decision on whether to make or buy the refrigeration component parts.

If he is very conservative, he will keep tooling to a minimum by buying parts—doing a certain amount of hand work rather than invest in expensive dies.

If he is optimistic about the market, he will want to make as many parts as possible—taking advantage of efficient tooling to keep the cost of each part low.

If he goes into car cooling with doubts about the extent and permanence of the market, he will probably want to amortize tooling as quickly as possible.

Needless to say, however, his decision will have a great deal to do with the price of the equipment. And price, in turn, will be a real factor in determining the market!

Be that as it may, the kind of performance built into a car cooling system may well determine the success or failure of the whole venture. The overall aim, of course, is to apply the components of an efficient cooling system to a car without affecting the utility or performance of the car itself.

Let us now consider what this involves. Actually, the basic elements of an air conditioning system are the same regardless of where it is used. They are:

Refrigerant
Power source
Compressor
Condenser
Liquid refrigerant control
Evaporator
Fans and air distribution system
Temperature and miscellaneous controls.

As we consider what each of these basic elements must and must not do, it might be interesting to note where each is located in one car air conditioning system. (See Fig. 1.)

Refrigerant—In addition to desirable operating and chemical characteristics, the refrigerant must be nontoxic. That's because refrigeration equipment may develop leaks.

Power source—A reliable source of power must be available to drive the refrigeration compressor and evaporator fans.

In a passenger car, the most logical power sources for these devices are: compressor—the car engine, fans—the vehicle electrical system. Such a fan drive presents no problems. Using the engine to drive the compressor does, however. That's because most refrigeration systems require a practically constant compressor speed. Therefore, simple belting to a variable speed automobile engine usually won't do.

Here's why: Within limits, compressor capacity

varies directly with speed. Thus, at low engine speeds, an engine-driven compressor won't produce enough refrigeration to do the job. And at high speeds it will produce too much. It boils down then to securing proper balance between evaporator and compressor so that sufficient cooling can be obtained at low driving speeds . . . yet still avoid evaporator icing at high speeds.

Various methods are used to do this. With one, the compressor is driven directly from the crankshaft by a belt drive . . . and compressor capacity variation due to change in engine speed is controlled by a unit inserted in the refrigeration system itself.

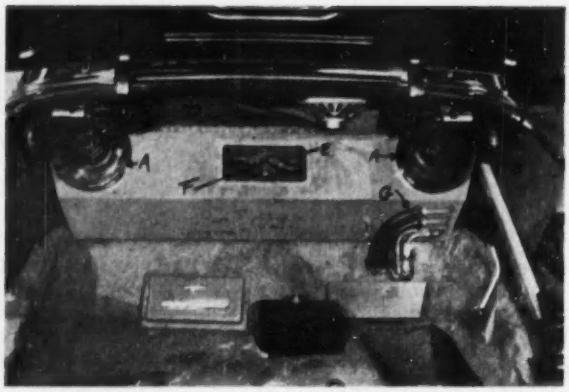


Fig. 2—The evaporator is installed in a relatively small space in the trunk compartment. Note the finned evaporator (F), thermostatic expansion valve (E), fans (A), fresh air intakes (B), cold air discharge passageways (C), warm air return duct (D), and the refrigerant lines (G)

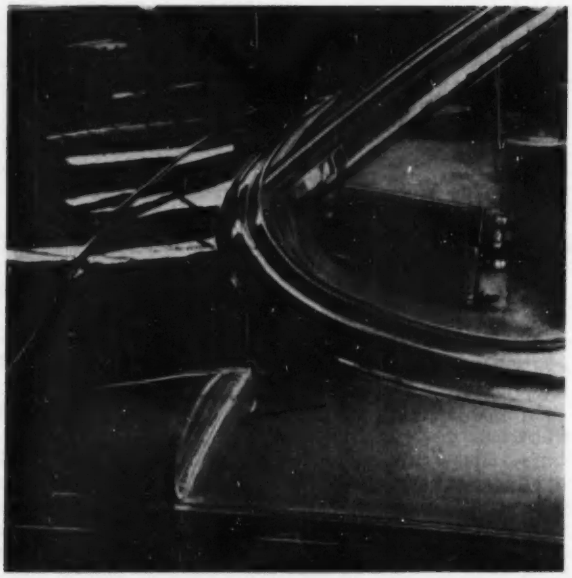


Fig. 3—Scoops on the side of the car supply much-needed fresh air continuously. Note also the cool air discharge outlets on the package shelf inside the car. Distribution ducts are attached to these outlets

Compressor—Both reciprocating and rotary compressors are used in automobile air conditioning systems. The idea is to use units that are as light, compact, simple in construction, and dependable as possible.

Condenser—Applying a condenser to an automobile is a ticklish job. It must be installed where the coolest possible air will always be available to condense the refrigerant. (This usually means in front of the car radiator.) At the same time, it must cause minimum interference with the engine cooling system. Providing ample air for cooling while a vehicle is at rest has been a major problem.

Refrigerant control—Methods of controlling liquid refrigerant commonly in use are manual control, automatic expansion valves, thermostatic expansion valves, capillary tubes, and float valves. Of these, the thermostatic expansion valve best meets the overall needs of an automobile air conditioning system.

Evaporator—Main purpose of an evaporator is to absorb heat from the space to be cooled. (It also removes excess moisture from the circulating air.) Fans bring the warm air to the evaporator. It's no secret that it is extremely important to prevent ice from forming on the closely spaced finned surfaces of the evaporator. To avoid this calamity, compressor and evaporator are balanced so that evaporator surface temperatures never go below 35 F.

The evaporator is installed in a relatively small space in the trunk compartment of a car. (See Fig. 2.)

Fans and air distribution system—Fans circulate the air through the evaporator and the occupied space of a car. They are driven by electric motors which receive power from the regular vehicle electrical system. Current consumption is relatively small—18 to 20 amp at 6 v.

Getting proper air distribution within the car is one of the toughest problems manufacturers have had to solve. That's because tolerable air velocity over the average individual for summer comfort is about 25 fpm. However, it's necessary to stay close to this limit because of the extremely small volume of air in a car per passenger. In fact, this latter condition necessitates that some fresh air be picked up continuously. This is accomplished by scoops on the side of the car. (See Fig. 3.)

Temperature and miscellaneous controls—Naturally dashboard controls are needed to operate and regulate the system. In some cases, these include a variable speed fan control and a temperature control, in addition to the switch for turning the system on and off.

Systems Deliver in Only Six Blocks

These, then, are the roles played by the individual elements that make up an automobile air conditioning system. The next logical question is: What kind of performance will systems as a whole deliver?

The answer to this depends largely on driving conditions. With continuous driving, it is possible on a 100 F day to produce comfortable interior conditions in approximately six blocks. If driving conditions are such that the take-off and subsequent

driving are accomplished at low engine speeds, a longer time will be required. At open-road driving speeds, comfortable conditions are easily maintained.

Beyond this, good system design calls for compactness and light weight; simplicity of installation; ready accessibility for service; minimum interference with air delivery to the car radiator; and maximum delivery of air at ambient temperatures to the system condenser.

Where to Put Bits and Pieces Together

Having decided on potential market, tooling, system layout and performance, each vehicle manufacturer will still have an all-important decision to make: Where to assemble all the bits and pieces —on the final assembly line, off the line, or in dealer service shops?

Final-line and off-line assembly appear to be the least costly approaches. But even they would require more floor space and extend assembly time of the automobile itself.

Installation by dealers would eliminate these two problems. However, it would cost more, increase car delivery time by two to three days, and necessitate special training of mechanics.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Based on Discussion

Question: How much power does it take to drive the compressor in Chrysler's air conditioning system when the car is driven at 25 mph?

Answer: About 2 to 3 hp. This is considered a minor sacrifice in power and fuel economy in view of the increased comfort to passengers.

Question: Does the weight of an air conditioning system affect ride adversely?

Answer: No. The heaviest elements are located at the front and rear where their mass is effective in reducing pitching tendencies.

Question: Have any attempts been made to use radiator water as a cooling medium, thus eliminating the aircooled condenser?

Answer: Considerable work has been done using radiator water as the cooling medium. Systems have been tried with electric, hydraulic, and mechanical drive to a compressor in the trunk . . . with trunk-mounted condensers. None of these arrangements offered sufficient overall advantages to justify adoption in place of the present system. Moving cooling air into and out of the trunk is far more complicated than handling it at the front of the car. And most of these arrangements were unduly costly. Electric drive involves use of a costly ac generator and rectifier, while hydraulic drive is expensive due to the pump, motor, and tubing required.

Question: Is the price of air conditioning for passenger cars likely to come down in the near future?

Answer: No.

Question: Is it advisable to use heat-resistant glass on cars equipped with air conditioning?

Answer: Heat-resistant glass is beneficial to air conditioning, but not essential. It gives a noticeable improvement in comfort on the sunny side of a car. What's more, the psychological advantage of heat absorbent glass should not be underestimated.

Question: Does solar radiation in hot weather impose much of an extra load on air conditioning equipment?

Answer: Yes.

Question: Is any provision made for this?

Answer: Yes. The "design" interior conditions (78 F, 50% humidity, 25 fpm air velocity) may be varied considerably to suit individual preference. This is especially true of the dry bulb temperature.

Diesel Combustion Studies . . .

. . . show cetane numbers from additives to be roughly equivalent to naturally obtained cetane numbers, but suggest that mechanism of additives' contribution differs from natural increase.

Based on paper by **W. Chow, O. A. Uyehara and P. S. Myers,** University of Wisconsin

FOR the purpose of studying the effect of additives on the diesel combustion process, tests were conducted with a CFR test engine, under different operating conditions, using four different fuels to which different amounts of butyl nitrate had been added. Further tests were then carried on with a specially instrumented GM 1-71 open-chamber diesel, using different additives.

Studies were made in the CFR engine to determine the effect of operating variables, fuel, and different amounts of butyl nitrate additions on ignition delay. These tests showed that the minimum delay is obtained with 8-deg injection advance, a compression ratio of 20, and with 5% butyl nitrate added, while the maximum ignition delay is obtained with no additive, early injection, and a low compression ratio. However, a longer ignition delay can be achieved (and have the engine still fire)

with a high-cetane fuel than with a low one.

Data obtained from tests with the GM 1-71 engine revealed that the use of an additive has essentially the same effect on the pressure-time record as the use of a fuel of higher cetane number. Study of the effect on flame temperature of a large number of additives gave data showing slightly higher temperatures when they are used, but the difference is less than the cyclic reproducibility.

With the GM 1-71 engine, it was also noticed that soon after injection occurred, the pressure, although still increasing, did not increase as rapidly as would be expected from the extension of the polytropic compression curve. To study this so-called pressure drop in more detail, hot motored diagrams were obtained, which showed that this drop did not occur for some small period of time after the indications of beginning of injection. At first, this delay was thought to be due to a strain gage on the rocker arm, but subsequent studies suggested that an additive affects the ignition delay period in a manner differently from that of different cetane-number fuels. It would seem logical to attribute this so-called decrease in pressure to the effects of fuel vaporization rather than to endothermic reactions. (Paper, "The Effects of Additives on the Diesel Combustion Process," was presented at SAE National Diesel Engine Meeting, St. Louis, Oct. 31, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Excerpts from Discussion

By R. W. Hurn
Bureau of Mines Petroleum Experiment Station

The pressure drops (or more accurately in engine cycles, the polytropic deviations) have been loosely attributed, in previous publications by the discusser, to "the vaporization effect." Actually, the major portion of heat transferred to the fuel prior to combustion is absorbed in the fuel as sensible heat. Within the normal diesel operating range, less than 10% of the heat necessary to bring the fuel to the combustion temperature is required as heat of vaporization. Therefore, it is important to recognize that these observed pressure phenomena following fuel injection do not necessarily indicate actual vaporization of the fuel.

By P. H. Schweitzer
Pennsylvania State College

We have seldom operated a CFR engine with such early ignition. With a 56-cetane fuel and 15.8/1 compression ratio, we found that the CFR engine gives maximum power with 10-deg injection advance and approximately 1-deg ignition before top center. With different compression ratios and different cetane fuels, the optimum injection advance would vary but never exceed 12.5 deg. With more injection advance, the engine is not only rougher but also has less power. So there is no advantage in such early injection and the authors could have limited their tests to the more relevant range of injection timing and avoided the very high rates of pressure rise.

By Ernest W. Landen
Caterpillar Tractor Co.

We have also observed, on direct-injection engines in our laboratory, that the fuel of higher cetane number has the shortest ignition delay and gives a smoother combustion with lower peak pressures. In this case a longer ignition delay allows more evaporation before ignition, causing a more vigorous reaction. In our precombustion-chamber engines, we can say that the ignition delay of the fuel should be measured in the precombustion chamber. However, as far as power is concerned the ignition delay must be considered in the main chamber. The two do not agree because after ignition in the precombustion chamber there must be a fuel transfer before ignition and burning in the main chamber. The ignition delay depends on a number of factors: speed, cetane number, timing, type of engine, compression ratio, engine load, injection equipment, boost and inlet air temperature. In the precombustion chamber of our engine operating normally, there is a definite pattern relating speed, cetane number, and ignition delay in milliseconds.

By Martin Berlyn
American Locomotive Co.

With reference to the open-chamber compression-ignition engine, it seems to me we desperately need some "mechanical cetanes", but I do not believe these should be sought by trick combustion-chamber shapes, nor is it necessary to depart from piston configurations having continuity of form. The fuel injection system offers the most promising avenue to realization of "mechanical cetanes." Considering the primitive nature of the injection equipment, with its fixed orifice nozzles, used in open-chamber diesels today, it is miraculous that it works as well as it does, which is not very well.

By A. W. Frazer
Department of National Defense, Toronto, Can.

I look on the combustion chamber as the most important part of the instrumentation. My experience is that simple changes of compression ratio work havoc with combustion processes. It is also my opinion that the slight modification of the combustion chamber of the GM 1-71 engine might seriously impair its normal efficiency.

Aircraft Powerplant Seals

Norman F. Rooke, Pratt & Whitney Aircraft Division of United Aircraft Corp.

Secretary's report of round table discussion on Aircraft Powerplant Seals and Their Application held at SAE Summer Meeting, Atlantic City, June 5, 1952. Leader was Floyd Norriss, Westinghouse Electric Corp.

AIRCRAFT powerplant engineers have been confronted with providing adequate sealing of fluid connections with rubber compound o-rings. Particular difficulty has been encountered in sealing against fuel leakage over a temperature range from −65 to +250 F, or higher. In some instances fluid connection leakage has been traced to improper installation of seals; however, cavity designs and inadequate o-ring materials have also contributed to leakage. Cutting of seals by fitting threads results in leakage.

The sealing problem has been aggravated by increasingly severe environmental conditions, and the swelling and solvent actions of fuel on synthetic rubber seals have resulted in dimensional changes in the o-rings during service operation. To correct these difficulties, powerplant engineers have been searching for improved rubber polymers and have conducted extensive test programs to evaluate rubber compounds and cavity designs by an accelerated test procedure.

Synthetic rubber seals have apparently reached their ultimate limit for fuel sealing applications, as can be judged from the following discussions, due to the action of the fuel on the seal material and the temperature extremes encountered with the present variety of polymers. The same can be said for their use in turbine engine synthetic oil and compressor hot-air bleed applications.

Metallic seals provide new concepts in various sealing applications beyond the synthetic rubber seal environmental limitations.

Aside from the environmental limitations, the present standard bulkhead positioning type fitting, with seal groove between double threads, requires turning to the direction of the connecting line. This installation does not provide means to prevent threads from cutting the seals in the fuel system.

The aircraft hydraulic system connection installation uses a leather backup ring above the seal which sets into a recessed jam nut. This prevents cutting of the rubber seal by the upper threads of the fitting when it is screwed in.

Seal protection is highly desirable. However, the current installation does not provide protection from cutting of the seal by the lower threads of the fitting, in either system, during removal of the fitting. Any shredded rubber particles might drop back into the fuel system, thus impairing the function of fuel controls or jet nozzles. Extreme care in removal and installation of these fittings and seal rings is a necessity. Consideration should be given to improvement in installation methods.

Special fittings or design configurations may resolve the fuel sealing installation problems; but if an entirely new series of standard fittings is required, it will be primarily due to the lack of adequate sealing with rubber compounds under such severe environmental conditions.

No broad standardization for industry general use has yet developed for high-temperature metallic sealing.

Synthetic rubber compounds for turbine engine fuel and synthetic oil sealing are presently limited to temperature extremes of −65 and +300 F. They are usually marginal at these extremes, but some special experimental compounds may possibly extend their marginal limitation to 350 or 375 F,

usually with some sacrifice to the lower temperature limit.

Temperatures reached in turbine engine fuel connections, in certain hot regions, may go as high as 400, 450, or even 550 F for intermediate time intervals. Adjacent parts may be 800–900 F, and the temperature increases after engine shutdown for a short period. Rocket engines transmit considerable heat back to the o-ring.

Metallic seals may be operated from −100 to 1000 F—with 1500 F the approximate intermittent peak temperature limit.

These facts emerged from the SAE round table on Aircraft Powerplant Seals and Their Application. Discussion was confined to static fuel-resistant seals and covered both nonmetallic and metallic seals. Some of the contributions made to the discussion follow.

Thermal Coefficient of Expansion for Rubbers—
J. W. Sackett, Thompson Products, Inc.

Some years ago it was shown that mold shrinkage, which is experienced when molding rubber, is actually thermal shrinkage due to the difference in molding temperature and room temperature. This is true except for a very small change due to chemical reaction of curing. Therefore it was thought that the following procedure for determining thermal coefficient of linear expansion would be accurate enough for design purposes:

- A four-cavity mold, 6×6 in. for each cavity, was accurately measured by tool inspection to the nearest 0.0001 in. at 25 C (77 F).

- Twelve TPR compounds were then molded in the above mold at 160 C (320 F). These 12 compounds were accurately measured by tool inspection at 22.22 C.

- From the coefficient of linear expansion of the mold and the temperatures of measurement and temperature of the molding cycle, the coefficient of linear expansion was calculated.

Coefficient of linear expansion ranged from 8.05×10^{-5} to 11.0×10^{-5}. Black carbon weight ranged from 22.2 to 46.7%. Durometer Shore "A" readings ranged from 50 to 76.

Volume Changes Due to Aromatics and Heat—
R. A. Clark, Battelle Memorial Institute

Work is done at Battelle on the swelling and drying of o-rings, confined and unconfined, at various temperatures. This work is part of a government-sponsored project aimed at shortening and improving Specification MIL-P-5315 on fuel o-ring packings. The present qualification tests in this specification now take about three months to complete. The objective of this research is to reduce this time to 30 days or less. Initial results obtained at Battelle show that this might be accomplished by using higher temperatures than are now required in the present specification for the various fuel-soaking and dry-out tests.

On the basis of the early results, the following generalizations appear to be indicated:

1. Small o-rings swell faster than larger o-rings, but reach the same percentage maximum and equilibrium swell values, within 1 or 2%. Tests were made on the two sizes of o-rings which fit the jigs used in conducting MIL-P-5315 tests. These are the −8 and −27 sizes. The fuel used was 30% aromatic (MIL-H-3136, Type III). It was expected that smaller o-rings would swell faster than larger o-rings, based on the larger surface area per volume of o-ring. However, it was not known that both small and large o-rings would reach so nearly the same final amount of swell.

2. Temperature affects the rate of swelling, but not the percentage maximum or equilibrium swell values (within 1 or 2%). The higher the temperature, the faster the rate of swell. This generalization is based on swelling tests conducted on o-rings at −65 F, 78 F, 120 F, and 160 F, in 30% aromatic fuel. Similar tests at 32 F and 212 F are being run. One of the objections which has been given to using higher temperatures to speed up the rate of swelling was that greater amounts of swell might be obtained. The results obtained at Battelle indicate that this objection is not warranted, and there is reason for optimism that the swelling periods in the present specification might be greatly shortened by swelling at higher temperatures.

3. At any one temperature a confined o-ring does not swell as fast as an unconfined o-ring, and reaches maximum and equilibrium values 5 to 10% below those of an unconfined o-ring. This is in line with thermodynamic studies which have been made on the swelling of rubber under tension by Flory and by others (principally Gee and Treloar). According to these investigations, the amount of swell should be greater for rubber under tension and less for rubber under compression. O-rings in a groove may be under both tension and compression, such as o-rings which are elongated by the I.D. of the groove but which are compressed in their cross-sectional dimension. However, the somewhat lower amount of swell obtained for o-rings confined in the MIL-P-5315 jig appears to indicate that compression is the dominant factor. The slower rate of swelling of confined o-rings is attributed principally to the smaller surface area directly in contact with the swelling media. Obviously, fluid cannot readily contact an o-ring at those points where the o-ring is contacting the metal surface of the confining metal components of the jig.

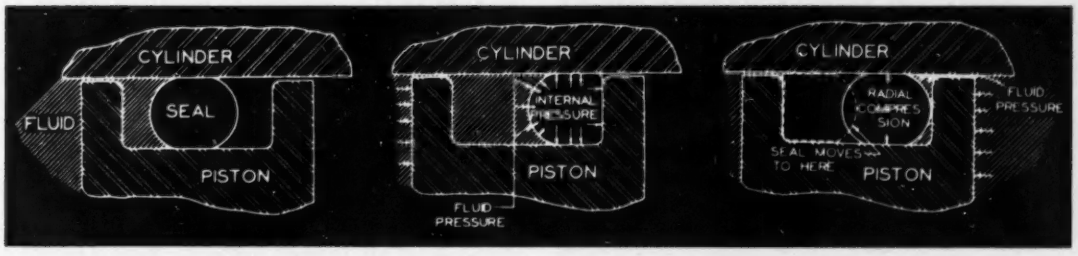
4. When oven dried, o-rings that swell more, shrink less. This conclusion would be expected by the rubber compounder. It is well known to the

o-ring manufacturers that it is the rubber component of a compound which swells, that carbon black and other inert fillers or pigments reduce swell by their dilution effect, and that plasticizers added initially for low-temperature flexibility actually cause shrinkage when extracted from the packing by contact with oil or fuel. By a proper balance of rubber, fillers, and plasticizers, the rubber compounder can largely control the amount of swell obtained. In the statement that o-rings that swell more shrink less, it is obvious that the o-rings that swell the most probably contain a greater amount of rubber and less carbon black and plasticizer. Consequently, there is less plasticizer to lose when oven dried, and this accounts for the lesser shrinkage.

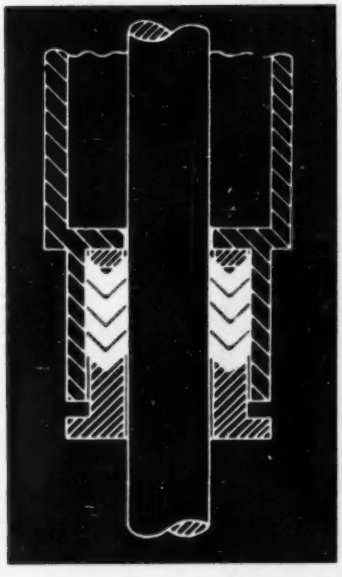
5. For any one type of o-ring, shrinkage at 160 F is no greater than shrinkage at 120 F, although the rate of shrinkage may be greater. It has not yet been determined how much time can be saved by drying at the higher of these two temperatures, but Battelle results show that it should be possible to use the higher temperature if necessary. One of the chief objections which has been made about

Here's what they look like . . .

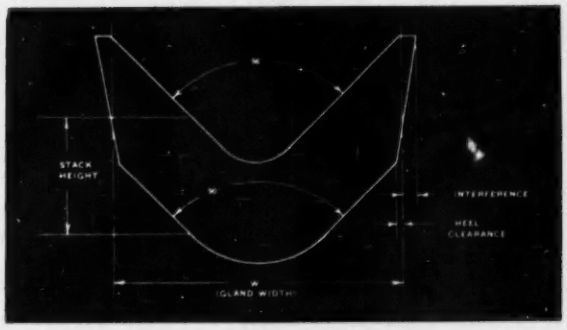
O-Ring Seal



(Sketches taken from booklet published by Linear, Inc.)



Chevron Seals



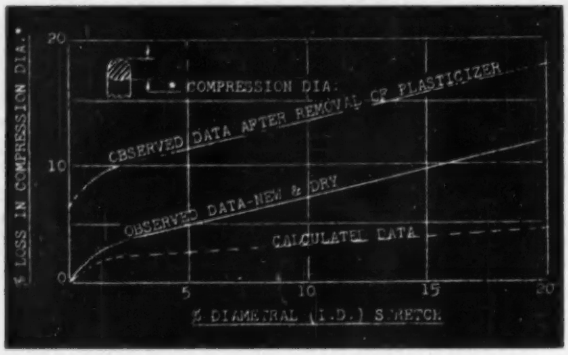


Fig. 1—Observed and calculated change in compression diameter due to stretch of o-ring. AN6227 series o-rings of 70 (Shore A) durometer reading (-6 through -20)

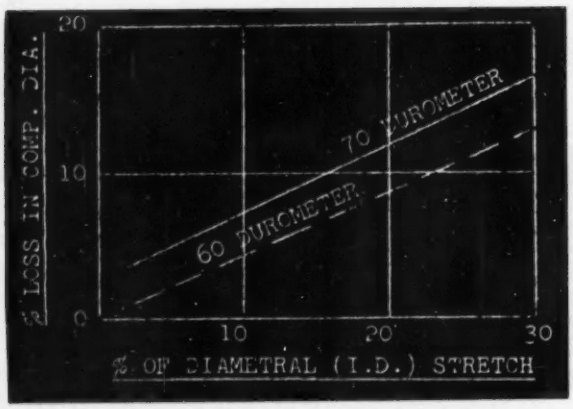


Fig. 2—Durometer hardness effect on diameter

drying at elevated temperatures is that more plasticizer might be lost and that this would reduce the low-temperature properties of o-rings tested in this manner. Since Battelle data show no greater shrinkage at the higher temperature, this objection does not seem well founded. Furthermore, the extraction of o-rings by fuel should be the dominant reason for loss of plasticizer, not drying. Dry-out tests are being made at room temperature for comparison, but the results are not yet available.

6. Shrinkage of equilibrium swell o-rings is approximately 2% greater than shrinkage of maximum swell o-rings. The maximum shrinkage at 160 F has been in the range of 12 to 18% for the different sources of o-rings tested. To help understand these data, it is well to define the terms used. In a plot of swell versus time, the amount of swell increases to a maximum in a relatively short time, then decreases a small amount and gradually approaches a plateau known as equilibrium swell. The contour of this curve varies with the rubber composition, with the swelling media, and with the temperature of swelling. The maximum in the swelling curve is attributed to swelling taking place faster than extraction in the initial phase of swelling. After this maximum swell has taken place, there still remains some unextracted plasticizer in the rubber, which we found to be about 2% for the o-rings tested. As this residual plasticizer is lost, the swell decreases to a limiting value described here as equilibrium swell. The comparatively narrow range of swell obtained for a number of o-rings indicates that the fuel o-rings tested did not differ widely in content of extractable plasticizers.

7. Maximum shrinkage is reached within 24 hr at 160 F. This merely indicates that dry-out tests in MIL-P-5315 might be reduced to 24 hr by using

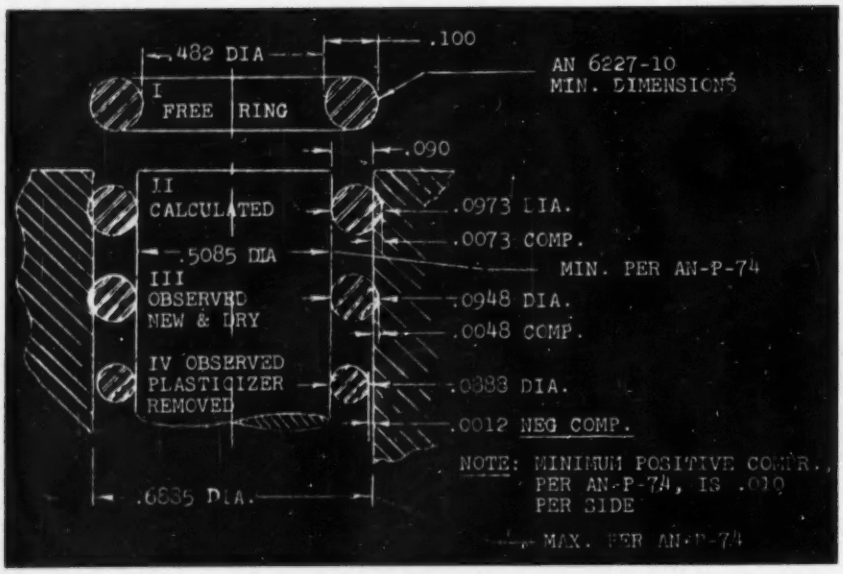


Fig. 3—Compression diameter variations with standard AN-P-74 dimensions when AN6227 size o-ring is used. No. 70 durometer (Shore A) only

160 F for drying. Unfortunately, the data for time required to dry at room temperature have not yet been obtained for comparison, but it is expected to take considerably longer.

Battelle will utilize the data obtained on rate of swelling and drying as a basis for suggesting a shorter qualification test procedure for Specification MIL-P-5315.

Further studies are being made by Battelle to determine (1) rate of swelling; (2) rate of drying of o-rings in fuel at various temperatures, confined and unconfined; (3) effect of such pre-treatment on leakage at low-temperature resilience test, and cycling endurance test of MIL-P-5315. Studies are to be made of test jig design and its ability to evaluate static, rotating, and sliding seal applications.

Effect of Stretch and Hardness—N. J. Lumm, Bendix Products Division, Bendix Aviation Corp.

Formerly, the stretch of the ring on the groove had been neglected in calculations of o-ring compression and in establishing tables such as those in AN-P-74. Some calculations on cross-section reductions were based on purely a volume basis. (See dotted line on Fig. 1.) Most of the calculations had assumed the ring would maintain a round cross-section while on the groove and have point contact at the groove. By actual tests and measurements, it has been shown that the ring actually loses cross-sectional dimension and assumes a flat contact area at both the O.D. and I.D. Fig. 1 illustrates the trend taken by the ring cross-section diameter when stretched.

Fig. 1 may tend to shift depending on the free durometer reading of new ring. This is shown in Fig. 2.

An illustration of the effects of stretch and volume loss due to plasticizer removal are presented in Fig. 3. These data are based on standard o-ring groove dimensions taken from AN-P-74. As can be observed, a negative compression condition exists at Step IV in Fig. 3.

The relationship of the dimensional change of the rings with swell is 1:3. That is, a 30% volumetric swell will produce an increase of 10% dimensional change in both cross-section and I.D. On this basis, the expected swell of the ring should be considered in groove dimensions.

As a comparison of AN-P-74 dimensions with those using the knowledge of the stretch relationship, Fig. 4 presents the o-ring compression to be expected, using a 60% volumetric swell ring and new groove and bore dimensioning.

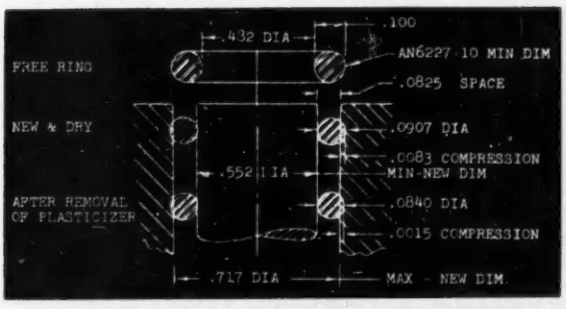


Fig. 4—Calculated compression diameter variations with revised bore and groove dimensions when AN6227-10 size o-ring is used

Polymerizing Compounds—R. C. Bascom, B. F. Goodrich Chemical Division

Four polymerizing compounds are:

1. Chloroprene (trade named Neoprene)
2. Nitrile (contains butadiene and acrylonitrile)
3. Polyacrylate (for −20 to 400 F)
4. Hypolene (being developed by DuPont)

Acrylonitrile content in nitrile or Buna N type compounds ranges between 18 and 40%. Where there is a high percentage of acrylonitrile, one can expect high tensile strength, high temperature resistance, poor low-temperature flexibility, and good resistance to oil.

Thiokol rubbers have exceptionally good resistance to fuel but are poor in compression-set qualities, and elasticity is not good at low temperatures.

Control of Rubber Characteristics—W. F. Tuley, Naugatuck Chemical Division, U. S. Rubber Co.

Control of characteristics is obtained by choice of base elastomer, compounding, and vulcanization.

The choice of rubber, the amount of reinforcing ingredients, plasticity, and the state of vulcanization affect the type of rubber product. The choice of type depends on the environmental forces to be contended with. Dimensional stability can be met by the manufacturer over a wide temperature range.

Polymer producers are interested in plasticizer control, abrasion resistance, and the temperature ranges encountered. Producers could probably do a better job for users if the two groups had more contact.

Characteristics of Elastomers—W. N. Keen, Rubber Laboratory, E. I. duPont de Nemours & Co.

We wonder if there has been enough consideration given to the thermoelastic characteristics of elastomers when designing o-rings and similar elastomeric parts. Fundamentally, all elastomers are

considered to exhibit three thermoelastic effects:

1. They generate heat on fast stretching.

2. When under a constant stress they contract visibly when heated.

3. The stress in elastomers held at a constant extension increases with rising temperature.

The second of these thermoelastic effects is the one commonly referred to as "Joule effect." This Joule effect may be demonstrated by suspending a weight from a rubber band and then raising the temperature of the rubber band by bringing a soldering iron or another heat source near it and observing the displacement of the weight. In general, everyone expects the weight to be lowered as the material expands; however, the reverse is true.

This Joule effect should not be confused with the coefficient of linear or cubical thermal expansion. The coefficient of linear thermal expansion of rubber is approximately 10 times that of steel. The values you find in engineering handbooks for the coefficients of linear or cubical thermal expansion for elastomeric materials have been determined, as would be expected, with the material under no stress or strain. Consequently, Joule effect does not enter into this measurement. In general, the higher the strain the greater the Joule effect.

T. J. McCuistion of Precision Rubber Products Corp. has applied these thermoelastic characteristics to the design of rotary seals for high-speed, high-pressure applications. He presented a paper on his work, "A New Rotary Seal for High Speed and High Pressure Applications," before the Rubber and Plastics Division of the American Society of Mechanical Engineers in November 1951.

It is these thermoelastic effects which have been, and are, worrying the designer of elastomeric automotive wheel suspensions. For example, a natural rubber suspension which imparts to the automobile the desired ride characteristics and roadability results in a change of car height of as much as 1.25 in. for a temperature change of 70 F. It is granted that an o-ring or a shaft seal is a long way from a wheel suspension; however, it is thought that this information would serve as interesting background to seal problems.

Problems with Static Seals—S. R. Doner, Raybestos-Manhattan Rubber Co.

The problem of finding a suitable static seal for various types of aircraft fuels is a difficult one.

From a rubber manufacturer's point of view it is difficult for the following reasons:

1. The low-temperature requirement of −65 F or lower limits one to the use of only one or two types of polymer. Unfortunately, these low-temperature polymers have high swell characteristics, particularly in aromatic fuels. This means that in many instances the seal will swell enough to extrude into any available clearance and cause shredding of the seal. This excessive swelling in aromatic fuel can be offset by the use of extractible plasticizers, but if the equipment is afterwards used with a non-aromatic fuel, excessive shrinkage of the seal will result in leakage.

2. Another factor over which we have no control, and a factor which is too often ignored, is the extremely high coefficient of thermal expansion of rubber as compared to metals. When a seal is confined and used over a wide temperature range, thermal expansion alone will frequently result in extrusion.

3. Another important requirement is good compression set, the ability of the material to return to its original molded shape after prolonged deformation. This is a characteristic which rules out some otherwise suitable materials.

I do not believe I have ever been classed as a pessimist, but I sincerely believe that the presently available rubber-like materials have been exhaustively tested for fuel applications and found wanting. Before better seals can be produced, I think we will have to develop a new rubber-like material.

The polyacrylate rubbers, for example, would be excellent for this purpose if the temperature range was between 0 and 400 F, but they become rock hard below 0 F.

Silicone rubbers possess the required temperature range but they are not resistant to aromatic fuels. Definite limitations can be found in all available materials. Certain Buna N materials come closest to doing the job so they are the ones used today.

Therefore, we must recognize the shortcomings of our present day materials and adapt our designs to the best possible comprise.

Teflon and Kel-F—Wesley Gordeuk, Westinghouse Electric Corp.

Teflon and Kel-F compounds may succeed in some applications, but are generally limited by their physical properties such as insufficient elasticity, slowness in recovery, and excessive hardness. A softer and more elastic Teflon or Kel-F seal could have all the desired properties for a fuel seal.

Silicone rubber seals may be adapted for higher fuel temperature applications by coating with a thin film of Teflon or Kel-F to prevent fuel from contacting the silicone. Connecticut Hard Rubber Co. has experimented with silicone seals, Teflon coated. Teflon bonding cement has been developed by Minnesota Mining and Manufacturing Co.

Pressurized Metal Ring Seals—F. E. Carroll, Jr., United Aircraft Products, Inc.

As early as 1933, the British were using "Wills" pressurized metallic o-rings, containing an inert gas in a hollow tubular section at about 600 psi. The rings were about 3/32 in. O.D., with 0.018–0.020 in. wall thickness, and welded to form a ring seal. When the rings are compressed between controlled

joint faces, the gas becomes active, tending to resist the external pressure, thereby maintaining contact with the sealing surfaces of the joint. These rings are exceptionally suitable in many applications where high operating pressures and temperatures are encountered. The British have experienced reuse of the rings two or three times before replacement was necessary.

In the United States, United Aircraft Products, Inc., Dayton, Ohio, makes the British "Wills" pressurized o-rings under license. After first making these rings in the 0.018–0.020 in. wall thickness, they are now about ready to produce these rings on a production basis with a thinner wall thickness of 0.012–0.016 in. The principal advantage of the reduced wall is to achieve less axial loading, or compression pinch, on the metal o-ring seal, because the heavier wall requires high compression loading which induces excessive stresses in the joint. UAP preflattens the rings 0.007–0.010 in. in order to obtain greater sealing surface area without the necessity of applying a high compression load. The O.D. of the ring is held to the gauge dimension during the flattening operation.

Ring materials generally used are: (1) stainless steel, type 321; (2) mild steel, SAE 1020—cadmium plated; and (3) aluminum. Other materials having the requisite properties and which are readily weldable are suitable for metallic seals. UAP flash welds their rings at the butted ends and controls the depth of the weld. Under quality control, if x-rays show a depth of weld to be excessive, 100% inspection of the batch is required.

Design of the groove to accommodate the seal ring is somewhat critical, and some variations from the general procedure of cavity design may be necessary to meet special conditions of pressure and temperature. A straight counterbore groove is generally used with fillet radii controlled so the radius will not interfere with the depressed configuration of the o-ring. Sealing surfaces should not exceed RMS63 and be free from radial and longitudinal tool marks. The seal ring should be confined by three surfaces, two by axial compression and one at the ring O.D., with initial clearance in the free state calculated to contact at the O.D. after deformation occurs due to compression. UAP Engineering Data Sheet No. 7-300 provides a general guide for groove dimensions and fitting instructions. UAP Sheet No. 67.030 gives standard sizes of metallic pressurized UAP rings. Ring sizes of 20 in. O.D. to 40 in. O.D. cost much more than smaller sizes. The general pressure limitation for the pressurized rings is 6000 psi.

Stainless steel pressurized o-rings are recommended for temperatures of 400–1000 F. Expansion takes place toward the fourth side in the groove. As the temperature rises, the ring, and the gas within it, expands to maintain contact of the ring at the O.D. Ring seals in magnesium have not been tested. But aluminum ring seals test satisfactorily. Pressurized seal rings have been used in rocket installations where the rings have been in contact with acids. A cold temperature test at −65 F was made with fuel up to 4000 psi, by increments of 100 psi, with no leakage. UAP rings can be reused four or five times.

Non-Pressurized Metal Seals—R. L. Skinner, Sr., Skinner Motors, Inc.

Skinner metallic seals are flexible-reed and chevron-type seals developed to replace the present nonmetallic seals which perform inadequately or are too marginal in the upper and lower temperature and pressure ranges. A number of advantages may be gained by using metallic seals in applications where nonmetallic seal materials are adversely aggravated by contact with jet fuels, aromatics, detergents, chemicals, gases, or a combination of these with temperature extremes.

Seals of Steelite, Inconel "X", cobalt, stainless steel, bronze and others are less affected by the difference between the coefficients of expansion of the seal and its mounting than are the nonmetallic seal materials.

Chevron seals do not require high compressive loading across the two edges of the V which are pinched, or tightened down to 0.004-0.008 in. overall to effect a seal. Lighter weight flanges or sealing joints can be used where axial-compression-type chevron seals are installed.

The axial-compression-type Skinner chevron seal is produced from tubular sections of Inconel "X" metal 0.003–0.005 in. thick forced outward under pressure into a backup ring designed with a groove to form the V pressed into it. Each edge of the V is ground flat to protrude 0.002–0.004 in. above each side of the backup ring thickness. This ring provides external support for the chevron and controls the seal pinch. The surfaces against which the seal seats should not exceed 12 RMS. Fluid pressure expands the chevron V and improves the sealing effect.

Skinner seals have performed satisfactorily under a constant temperature of 1300 F under 400 psi and up to 1680 F intermittent temperature. These seals are also used in jet nozzles at 1000 F under 1000 psi. Shot peening of stainless steel raises the temperature it can withstand about 300 F. The maximum sealing pressure is about 30,000 psi. Some seals were made for ramjets. The Skinner metallic seals can be reused several times.

Chevron Seal Tolerances—Williams Watkins, Fulton Sylphon Division, Robertshaw-Fulton Controls Co.

The Fulton Sylphon Division has been licensed by Skinner Motors, Inc. to produce the Skinner metallic seals and can now produce the flat-type chevron seal (without metal backup rings) by forming the three "V" elements into each other. The ring O.D. can be held to ± 0.010 in. and at extra cost the O.D. can be held to ± 0.005 in. A groove clearance of 0.010 in. minimum over the maximum ring O.D. is recommended to allow for expansion. The interference fit without backup ring should not exceed 0.011 in. total.

Skinner metallic seals were installed in a single-cylinder diesel fuel pump and ran at 1700 rpm with pump outlet pressure of 0-2400 psi without seal leakage.

Comparison of Tests for

Hardenability of Shallow-Hardening

G. K. Manning, Battelle Memorial Institute, Chairman of ISTC Division V

Report prepared for Division V on "Jominy and SAE Hardenability Tests on Seven Shallow-Hardening Steels—A Cooperative Program Among Ten Laboratories Sponsored by SAE Iron and Steel Technical Committee Division V".

WITHIN recent years several kinds of hardenability tests have come into general use for production control of engineering parts which are to be quenched and tempered. Such tests are used to measure the depth to which a steel will harden when quenched under carefully controlled conditions.

One of the most commonly used hardenability tests is the Jominy test. A 1-in.-diameter round, 3 or 4 in. long, is quenched on one end by a jet of water. The water touches only the flat end of the specimen. After quenching, flats are ground along a diameter, and Rockwell "C" hardness measurements are made along the flats, usually at increments of 1/16 in. from the quenched end. By plotting the hardness versus the distance from the quenched end, the hardening characteristics of different steels may be compared.

Another commonly used hardenability test is called the SAC test, detailed on pages 116–119 of the 1953 SAE Handbook. A 1-in.-diameter round, 4 in. long, is quenched by completely immersing the specimen in water and providing for considerable agitation of the water during the quench in some manner or other. After quenching, the specimen is cut in two midway along its length, and Rockwell "C" hardness measurements are made on the cut surface. Hardness readings are made at 1/16-in. intervals along two diameters at right angles to each other and on the surface of the test bar. The area under the hardness versus "distance from the surface" curve is computed; and it is customary to report the surface hardness, the area under the curve, and the center hardness. The test derives its name from the method of reporting the results—that is, surface, area, and center.

The SAC test is suitable only for shallow-hardening steels, it being obvious that the test will not distinguish between steels which will harden completely through in sizes larger than 1-in. diameter. The Jominy test, however, is suitable for steels of considerably greater hardenability.

About five years ago, Division V—Methods of Determining Hardenability of the SAE Iron and Steel

Table 1—Chemical Compositions of Steels Used

SAE Grade	Chemical Analysis, %									Grain Size[a]
	C	Mn	Si	P	S	Ni	Cr	Mo	Cu	
1030	0.30	0.85	0.23	0.022	0.027	0.05	0.08	0.02	0.05	6.5–8.0
1042	0.42	0.72	0.22	0.014	0.030	0.14	0.07	0.04		6.0–8.0
1046	0.49	0.73	0.22	0.012	0.034	0.10	0.08	0.06		6.0–8.0
1078	0.84	0.40	0.18	0.010	0.041					5.0–7.5
4027	0.26	0.67	0.25	0.015	0.030	0.18	0.13	0.24	0.10	6.5–8.0
8617	0.19	0.91	0.24	0.028	0.019	0.70	0.49	0.20	0.08	6.5–8.0
Tool Steel	1.05	0.36	0.35	0.014	0.009					

[a] By the ASTM McQuaid-Ehn Test

Steels

Technical Committee undertook a cooperative testing program of four rather deep-hardening steels, SAE 8640, SAE 8720, SAE 4150, and SAE 4340 using the Jominy test procedure. The object was to determine how nearly one laboratory could reproduce the results obtained in another, and to establish, if possible, what variables were most likely to lead to discrepancies between laboratories. It was found that if the same austenitizing procedure was used, if the decarburized layer was completely removed from the surface of the bar, if tempering during grinding of the flats was avoided, and if the water temperature was between 65 and 85 F, then the various laboratories duplicated one another to what was considered a satisfactory degree.

Since many shallow-hardening steels are tested by automotive companies, Division V decided in 1950 to extend its cooperative testing to plain-carbon and low-hardenability grades of steel. Two types of tests were to be used: the SAC test, because it was currently being used by some steel consumers, and the Jominy test, because work at the Chrysler and United States Steel Laboratories had indicated it might also be suitable for shallow-hardening steel.

Testing Program

The metallurgical laboratories of 10 companies, Bethlehem Steel Co., Caterpillar Tractor Co., Chrysler Corp., Crucible Steel Co., Ford Motor Co., General Motors Corp., International Harvester Co., Republic Steel Corp., Timken Steel Co., and the United States Steel Co. participated in the tests. Seven steels were supplied by the steel-producing companies mentioned above as 1¼-in.-diameter rounds. Sufficient material from a single bar was sent to each laboratory for six specimens, and the material sent each laboratory was identified in such a way that its location in the original bar could be determined if necessary.

Six shallow-hardening SAE grades of steel were

THE section on Hardenability Tests for Shallow-Hardening Steels in the 1953 SAE Handbook has behind it the work described in the accompanying article.

(The section on Hardenability Tests for Shallow-Hardening Steels was approved in January 1953 as an addition to the SAE Recommended Practice on Methods of Determining Hardenability of Steels, which appears on pages 112-120 in the 1953 SAE Handbook.)

Division V investigated both a modified Jominy test method and the SAC test method. They concluded:

1. Either the SAC or the Jominy test will yield reproducible results in testing shallow-hardening SAE steels, provided the precautions indicated in the SAE Recommended Practice on Methods of Determining Hardenability of Steels are observed. High-carbon tool steels appear to require some extra precautions not included in the Recommended Practice if reproducible results are to be obtained.

2. There is no advantage in using either Rockwell "A" or Rockwell "30N" over using Rockwell "C" in testing shallow-hardening steels, even though closer spacings may be used with Rockwell "A" and "30N." There may be some advantage in staggering the Rockwell "C" determinations so that readings are obtained at less than 1/16-in. intervals.

3. It is possible to convert Jominy data to SAC data with reasonable accuracy by employing a curve which relates the cooling rate of one specimen to that of the other.

On the basis of these conclusions, they recommended that both the modified Jominy and the SAC test be part of the SAE Recommended Practice and be printed in SAE Handbook until experience indicates that one of the tests—or some other method—is superior.

Division V—Methods of Determining Hardenability is a division of the SAE Iron and Steel Technical Committee.

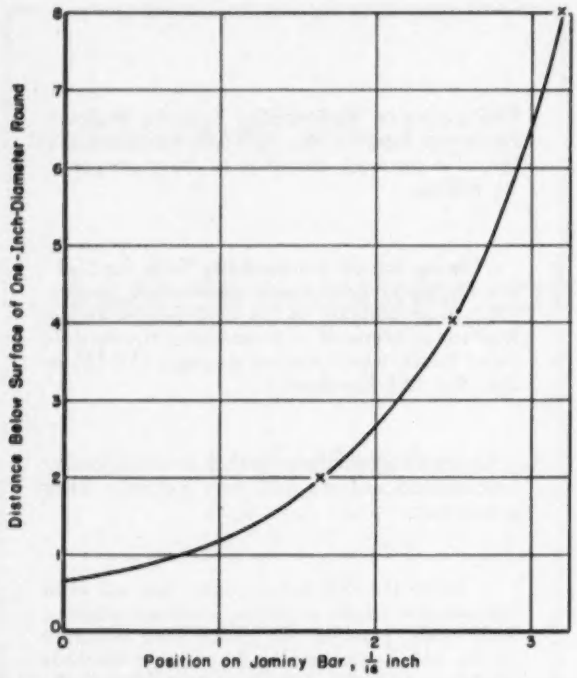


Fig. 1—Positions of equal cooling rates at 1300 F on Jominy bar and 1-in.-diameter rounds quenched in mildly agitated water. Determined by use of cooling-rate data given in the SAE Recommended Practice on Methods of Determining Hardenability of Steels

tested. Their chemical compositions and SAE designations are given in Table 1. One tool steel was tested, and its chemical composition is also given in Table 1.

SAE Grades—Each of the 10 laboratories tested duplicate specimens of each of the six SAE grades of steel, both in Jominy tests and in SAC tests. All the specimens (both Jominy and SAC) were normalized and then austenitized according to the SAE Recommended Practice on Methods of Determining Hardenability of Steels in the SAE Handbook. The SAC specimens were quenched in a jig designed by the International Harvester Laboratories, except for the SAC specimens tested in one laboratory. This one laboratory simply agitated the specimens with tongs while quenching. However, the results obtained were not different than those obtained by the other nine laboratories, so the data were included with the other results. The quenching jig used by the nine laboratories for SAC tests was so built that the specimen was held by knife edges in the center of a pipe. Water was directed toward the side of the specimen through six slots 1/16 in. wide by 5 in. long. The special jig was used because originally it was thought that the quenching conditions would have to be very carefully controlled if the different laboratories were to duplicate each other's results. However, since

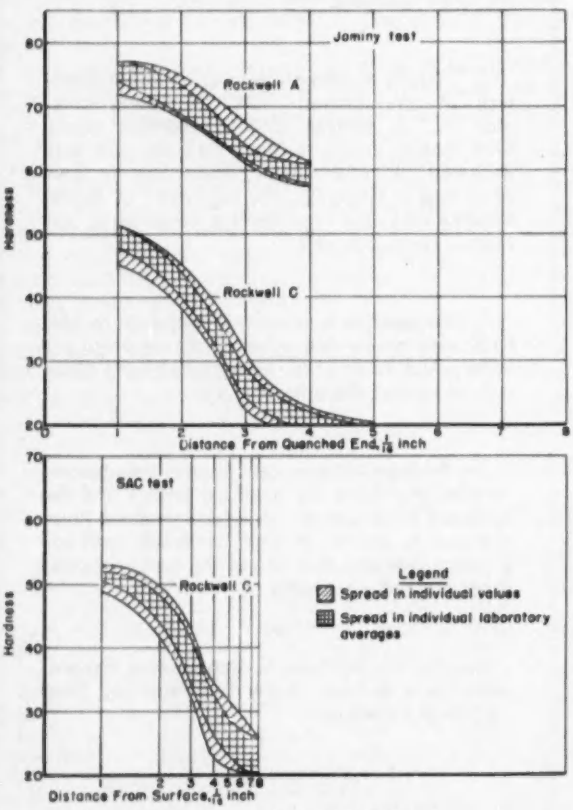


Fig. 2—Test results on SAE 1030 steel

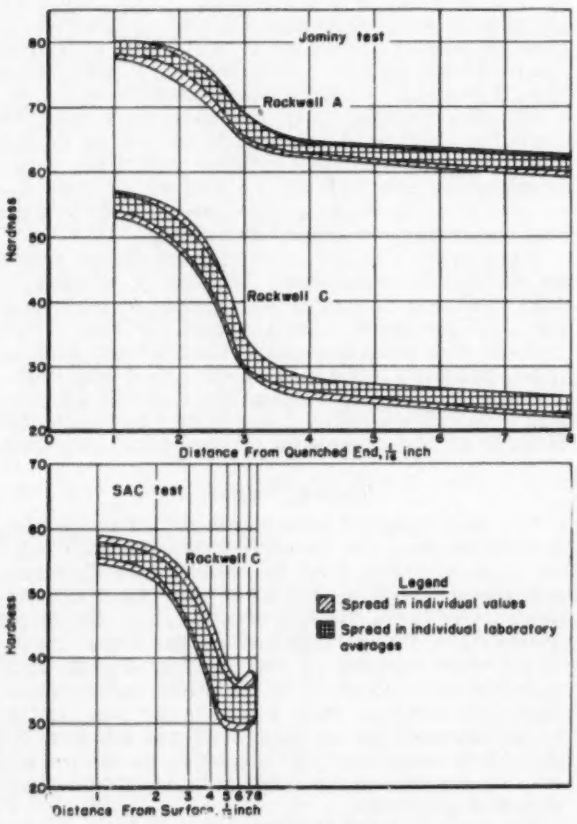


Fig. 3—Test results on SAE 1042 steel

one of the laboratories obtained comparable results using only hand agitation of the SAC specimens during quenching, and a second laboratory made additional tests employing only hand agitation with almost identical results, it appears that additional work would be required to establish what precautions are necessary when quenching SAC specimens.

Four instead of the usual two flats were ground on the Jominy specimens. Rockwell "C" readings, spaced at 1/16-in. intervals, were made on two of the flats. As a check on the positioning anvil used on the Rockwell machine, each laboratory measured by means of a metallurgical microscope the distance from the quenched end of the Jominy specimen to the center of the Rockwell indentation. It was found that the positioning anvils (they were all of the type described in the SAE Recommended Practice on Methods of Determining Hardenability of Steels in SAE Handbook) were usually accurate to ± 0.003 in. of the nominal position, and always accurate to ± 0.005 in. Such small errors as this are not discernable when the results of Jominy tests are plotted in the customary manner, and it was concluded that any of the jigs shown in the SAE Handbook is capable of properly spacing the Rockwell indentations.

The SAC specimens were cut midway along their length and, since duplicate specimens were made by each laboratory, this yielded four cut surfaces of each steel. All four of the surfaces were used for Rockwell "C" hardness impressions. Four surface-hardness determinations were made on each half of each SAC specimen and in addition, hardness determinations were made along four radii of the cut surface at 1/16-in. intervals from the surface. (Of course, only one "center" hardness reading could be made on each half specimen.)

All the laboratories etched the ground surfaces upon which hardness determinations were to be made to be certain that tempering had not occurred during cutting or grinding.

Tool Steel—All the tool steel specimens were oil quenched after 45 min at 1600 F in order to establish a prior structure that was uniform and free of massive cementite particles. Each laboratory then quenched two Jominy and two SAC specimens after each of two austenitizing treatments, 30 min at 1600 F and 30 min at 1450 F. The data obtained from the SAC specimens on tool steel would not necessarily have to be reported as surface hardness, area in Rockwell inches, and center hardness. It might be reported as hardness penetration. In that case the test would be similar to the P-F test except that a 1-in.-diameter rather than a ¾-in.-diameter specimen is used. The quenching pro-

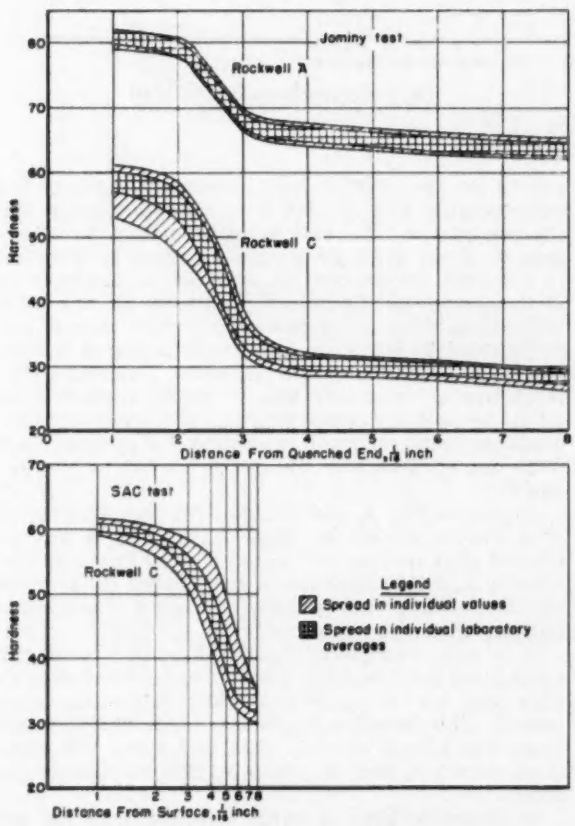


Fig. 4—Test results on SAE 1046 steel

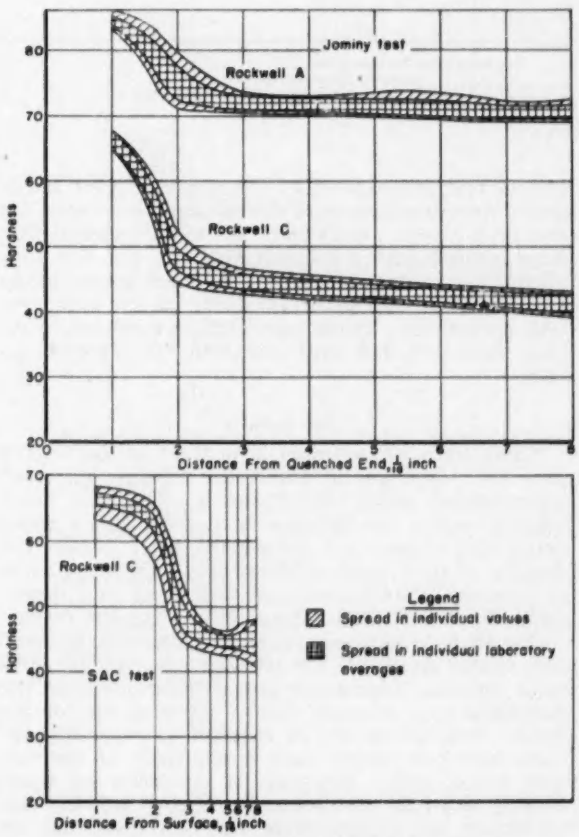


Fig. 5—Test results on SAE 1078 steel

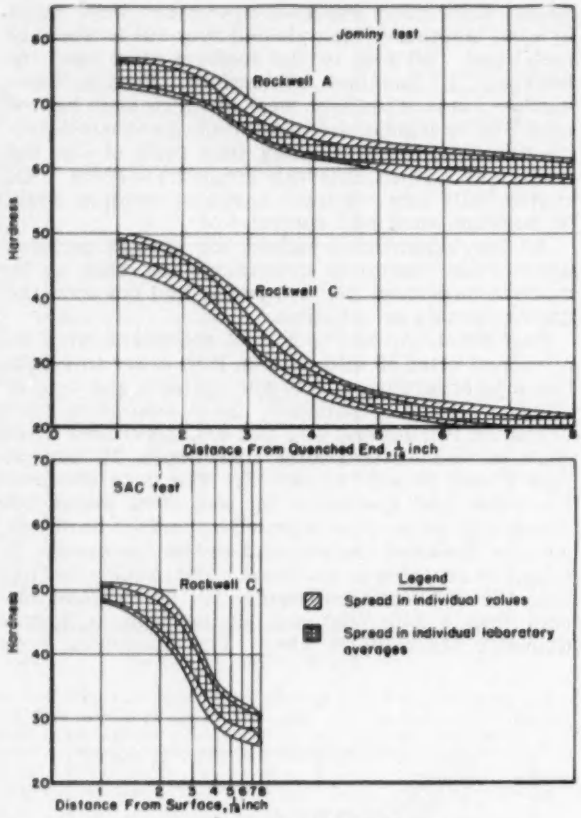


Fig. 6—Test results on SAE 4027 steel

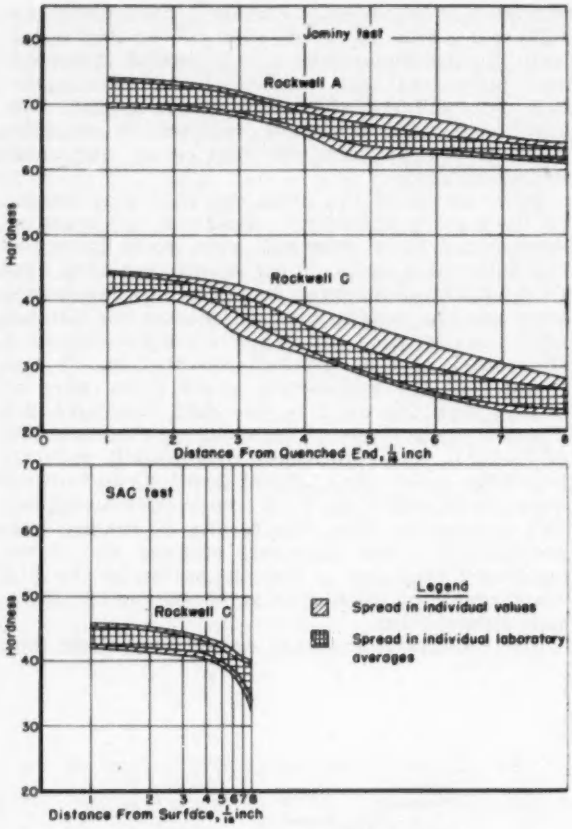


Fig. 7—Test results on SAE 8617 steel

cedure and preparation of the specimens for hardness determinations were the same as those used for the SAE steels. Rockwell "A" and Rockwell "C" were made on the Jominy specimens, but due to a misunderstanding most of the laboratories made only Rockwell 30N determinations on the tool steel SAC specimens. Three laboratories, however, made both Rockwell 30N and Rockwell "C" determinations.

Test Results

There were two primary objectives of the testing program. One was to determine whether different laboratories could satisfactorily duplicate each other's results on shallow-hardening steels when using the same test procedure with either the Jominy or SAC hardenability test. The second was to compare the Jominy and SAC tests and determine if one was more reproducible than the other.

The surface hardness, area in "Rockwell-inches," and center hardness are usually reported for SAC tests, whereas a hardness versus "distance from the quenched end" curve is usually reported for Jominy tests. This difference in method of reporting results does not permit easy comparison of the two test procedures. However, if positions of equal cooling rates for the Jominy and SAC test are determined, the results from the two tests may be shown in a comparable manner. The locations of points on the Jominy test specimens having the same cooling rate at 1300 F as positions below the surface of the SAC test specimens may be interpolated from work by Boegehold that is included in the SAE Recommended Practice on Methods of Determining Hardenability of Steels in the SAE Handbook. Fig. 1 shows the curve. Since the curve must be based on only three points it is subject to appreciable error. However, since the primary use of the curve was to obtain a scale that might be used for comparing the two types of hardenability tests, errors in matching the cooling rates were not critical, and the curve proved to be adequate.

By use of Fig. 1, the abscissa for the SAC hardness curves shown in Figs. 2 through 9 was so altered that positions of equal cooling rates on the Jominy and SAC specimens are located on a vertical line. Doing this permits making a direct comparison of the two test methods.

It is apparent from Figs. 2 through 7 that the agreement between the 10 laboratories was remarkably good for the six SAE shallow-hardening steels tested. The spread in hardness values was even less than was found several years ago when the same laboratories tested a group of deeper hardening steels.

It should be kept in mind, however, that the results do not indicate the range in hardenability that

may exist among different heats of a given SAE grade, but only indicate the ability of one laboratory to check the results of another when using the same steel and the same test procedure.

It is also apparent in Figs. 2 through 7 that an almost identical degree of reproducibility is obtained from the SAC test and Jominy test. Note that the width of the hatched bands for the SAC test results closely duplicate the width of the hatched bands for the Jominy test results. The two test methods may also be compared by projecting the SAC scale onto the Jominy bar and computing SAC "area values". The results of this are indicated in Table 2. Note that the calculated area based on the Jominy test usually differs by less than 5% from the observed SAC area value. Such a calculation is, of course, awkward and tedious and not recommended as a standard procedure. However, Table 2 does indicate that the two tests can be compared when it is necessary.

There appears to be no advantage in using Rockwell "A" determination on the Jominy tests spaced at 1/32 in. The Rockwell "A" scale is a more condensed one than the Rockwell "C" scale (1 point Rockwell "A" corresponds approximately to 2 points Rockwell "C"), and since the widths of hatched bands for Rockwell "A" are almost as wide as the hatched bands for Rockwell "C," it appears that it may even be advantageous to use Rockwell "C" and the coarser spacings. Very likely the best procedure would be to use the Rockwell "C" scale and to so stagger the hardness indentations that readings are obtained at each 1/32 in. for the first 3/8 or 1/2 in. from the quenched end. This, however, was not in-

Table 2—SAC Area Values

SAE Grade	Individual Values Calculated from Jominy Bar Data, Rockwell in.		[a]Laboratory Averages, Rockwell in.	
	Minimum	Maximum	Minimum	Maximum
1030	30.4	38.6	32.1	37.1
	32.6	40.4	34.2	38.8
1042	39.4	47.0	40.6	45.4
	40.2	46.2	42.0	45.6
1046	44.0	52.2	45.9	49.4
	41.8	50.5	44.8	48.9
1078	48.2	53.8	50.0	52.9
	48.4	53.0	49.4	52.2
4027	34.0	40.1	35.5	39.0
	37.5	44.4	39.4	43.0
3617	39.4	43.4	40.1	42.9
	37.4	43.2	39.9	42.4

[a] Each value represents an average of two test bars (4 hardness readings).

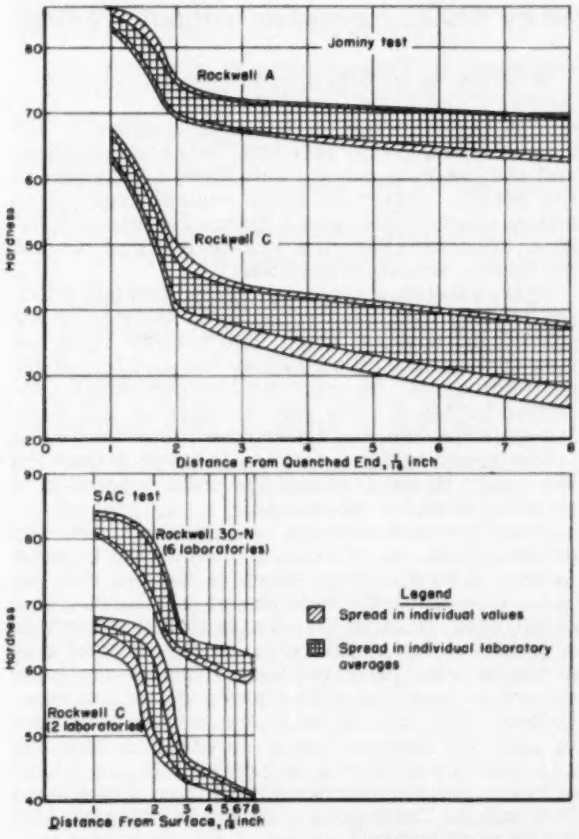


Fig. 8—Test results on tool steel quenched from 1450 F

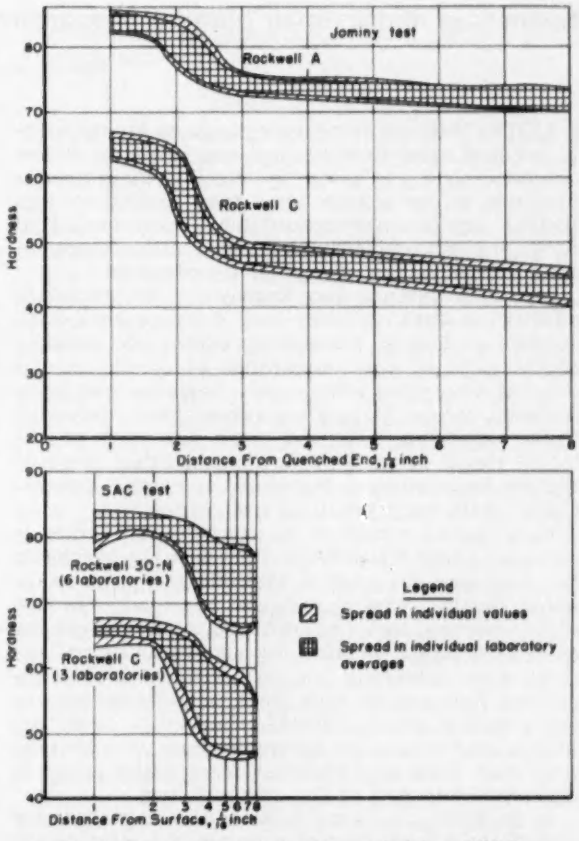


Fig. 9—Test results on tool steel quenched from 1600 F

cluded in the testing program.

Figs. 8 and 9 indicate there was less reproducibility in test results on the tool steel. This is particularly apparent in Fig. 9 when the 1600 F quench was used. It appears, since the test specimens gave satisfactory results for the SAE grades, that the wider hatched bands with the tool steel were caused by differences in heating rates as the specimens were heated for quenching. In the case of the SAE steels with their lower carbon content, all the carbides would be in solution prior to quenching regardless of the heating rate. The tool steel, however, might be spheroidized to different degrees depending on the heat rating.

The use of Rockwell "30N" hardness determinations for the SAC tool-steel tests does not appear to have in any way decreased the range in values obtained between different laboratories.

It is interesting to speculate about the cause of the variations in hardenability results on the SAE steels even though the variation was small. It may be noted that in the case of the Rockwell "C" Jominy test data on the SAE steels the width of the hatched bands is in most cases nearly constant from the quenched end to the 8/16-in. position. This makes it appear that the principal factor limiting the reproducibility of the test is the accuracy of the hardness readings. Segregation of carbon and alloys would cause the hatched band to be broad near the quenched end but narrow farther back beyond the point of inflection. The same would be true if the difference were caused by grain size or microstructure just prior to quenching.

The data were checked to see if there was a marked tendency for the laboratory reporting the lowest values with one steel to also report the lowest values on other steels. Such a condition would suggest improper calibration of the Rockwell machine. However, this was not found to be the case. A laboratory reporting the lowest values on one steel was as likely as not to report the highest values on another steel. Therefore, one can only conclude that a major part of the width of the hatched bands must be attributed to an approaching of the limit of accuracy of the Rockwell "C" hardness test.

Jet Operating Costs . . .

. . . can be cut substantially by component replacement in line maintenance. Effectiveness of minor repair program demonstrated by 1000-hr operation without overhaul.

Based on paper by **Charles E. Dixon,** Allison Aeroproducts Operations, CMC

LATE in 1949 a minor repair program for centrifugal and axial-flow engines was initiated at two domestic Air Force bases. In this line-maintenance program, minor repairs have been limited to "hot section" components because it has been found that need for parts replacement in this section is responsible for the return of engines for overhaul.

Line maintenance may employ two procedures in addition to work normally done during specified inspections. One is preventive, calling for periodic replacement of parts regardless of condition; the other is corrective, which covers work done or parts replaced when inspection reveals the necessity. From experience acquired since the start of the minor repair program, it is apparent that the corrective maintenance approach to engine serviceability is the most practical and economical.

In a recent survey of 75 centrifugal engines it was found that the average time between overhauls has increased from 130 to over 500 hr by the use of minor repairs. The average cost per repair was 25% of the overhaul cost. At another AF base, before the axial-flow minor-repair program was started, engines were averaging one-half their allowable operating time before they were pulled and sent to the overhaul depot. Today, the actual operating time is over 80% of the allowable time. The average total cost, labor and material, for a minor repair is approximately 30% of the overhaul cost.

In addition to outright saving in maintenance cost, there is a substantial saving in time and money due to the reduction in the total number of engines involved in the "pipe line" between operations and the overhaul depot. This gives a reduction in the overall number of spare engines required to maintain operations, and a higher use level per engine. Consequently, the engine operational cost per hour is materially reduced.

Of the axial-flow engines processed through minor repair, 70% have been returned to service; of the centrifugal engines, 80%. The balance upon review at the minor repair facility was sent to a major overhaul depot. It must not be overlooked that certain replaced parts can be repaired and used. For example, cracked inner liners may be welded and returned intact to service, or nozzle diaphragm vanes may be replaced and the units reinstalled or returned to supply for reissue.

When the first turbojet, an axial-flow J35, had finished 1000 hr without a major overhaul in August, 1951, the effectiveness of the program became apparent. By December of that same year a centrifugal J33 accumulated over 1000 hr. Evidence is rapidly accumulating that, on the basis of cost per horsepower per flight-hour, turbojets are going to provide operators with a new order of low costs. (Paper, "Cost Savings by Component Replacement in Line Maintenance," was presented at SAE Annual Meeting, Detroit, Jan. 15, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

How to Attain Results with Quality Control

W. F. Stryker, Douglas Aircraft Co., Inc.

Report of Panel on Quality Control held as part of the Aircraft Production Forum at the SAE National Aeronautic Meeting, Los Angeles, Oct. 1, 1952. Panel leader was B. W. Clawson, Douglas Aircraft Co., Inc., and coleader was George H. Prudden, Lockheed Aircraft Corp.

MANAGEMENT of today expects that quality control will produce the following:

1. Promotion of operator enthusiasm for quality.
2. Indoctrination of new employees with quality mindedness.
3. Aid to purchasing departments in establishing good vendor relations.
4. Prevention of rejections and elimination of sorting.
5. Early detection of adverse quality trends.
6. Assurance that quality is being built into the product.
7. Measurement of quality.
8. Preparation and distribution of reports on quality levels.
9. Control of processes.
10. Sharp reduction in inspection costs by shifting emphasis from inspection to prevention.

Other forces were reported to be currently at work to assist the upgrading of quality control efficiency throughout the industry. For instance, the Inspection Committee of the Aircraft Industries Association is now engaged in research with some twenty companies concerning the problem of 100% inspection versus sampling inspection. The results of this research will be combined into a report that will be available to the industry. The military services have also been engaged in a program of clarification of the Government sampling table MIL-STD-105-A. This item is considered of critical importance to all quality control operators in that the scientific selection of lot sizes is a very important factor, since it affects the purchase and use of equipment, along with a number of other factors. Much has been done along these same lines by the AIA and the military services to clarify the requirements and interpretations of MIL-Q-5923A for industry.

Functional Testing

Prime contractors perform functional testing of radio and electronic equipment because of the complexity and delicate nature of present-day equipment, coupled with the possibility of shipping damage. Moreover, under military contracts, MIL-Q-5923A makes functional testing a mandatory requirement in establishing the specification compliance of the completed article being delivered to the customer.

Radio and radar electronic equipment was reported as being tested at two points in the manufacturing sequence. First, a bench test ensures it is in an operable condition, and second, a functional test in the installed condition ensures final specification compliance.

Plant facilities groups in coordination with engineering departments were disclosed as the agencies held responsible to provide the test equipment, in all instances, with a variation existing between some organization in the assigning of responsibility for operating test equipment. Some organizations were using a specialist group to operate functional test departments with inspection also assigned as a measure of quality control. In others, the entire test department was operated by inspection alone, on the theory that economically there was much to be gained from this latter practice, inasmuch as it eliminated duplication in personnel.

Effecting adequate coordination between the vendor's and prime contractor's test specification is considered a two-fold problem. Where the prime

Complications of quality control were unraveled by these experts (left to right): R. S. Catlin, Northrop Aircraft, Inc.; Secretary W. F. Stryker, Douglas Aircraft Co., Inc.; Panel Coleader George H. Prudden, Lockheed Aircraft Corp.; Panel Leader B. W. Clawson, Douglas Aircraft Co., Inc.; Roy E. Paine, Aluminum Co. of America; I. Dagan, Rohr Aircraft Corp.; George H. McDonald, North American Aviation, Inc.

contractor imposes functional test requirements on a subcontractor, it was felt that he should furnish the test specification. The subcontractor operates to the test specifications as furnished or arbitrates such differentials as may occur. When a vendor is furnishing a proprietary item, the prime contractor generally obtains his test specification data from the article supplier and operates to it, or again arbitrates such differentials as may exist. In all cases, the design engineering groups responsible for the initial design and specification approval of the article involved were noted as the agencies furnishing the details comprising test specification data.

It is considered better practice to test articles before they are placed in stock so as to ensure that corrective action can be taken, whenever required, prior to the lapsing of the manufacturer's warranty on the article. Rejections, it was noted, are generally cyclic in nature.

The test equipment itself may be calibrated by any of a number of departments. Engineering, plant facilities, plant engineering specialty groups, inspection and process control were among some of those responsible for this function within the different organizations reported. In all cases, however, their responsibilities were identical in that they calibrated and maintained test equipment to industry-accepted primary standards.

In regard to the identification of items rejected as a result of functional tests, it was pointed out that military spec MIL-Q-5923A requires that rejectable GFAE (government-furnished aircraft equipment) and CFE (contractor-furnished equipment) functional test items be isolated only, without mutilation by rejection stamping. Identification tags, reject and rework tags, and other like types of shop paper were some of the suggested ways of taking care of the rejects.

Some prime contractors require their vendors to furnish detailed test data and others ask for practically no data. All agreed that the purchase order was the medium through which this requirement would be established to the vendor.

The point of installation for electronic equipment is an item of major importance in controlling rejections. Where the position for installation of this equipment could be selected as late in the manufacturing sequence as possible, much was gained in the elimination of tinkering and shop damage.

Prime contractors always seem to return their line rejections relating to functional test items directly to their test groups for evaluation and action, as required.

It was generally agreed that rejections are not discriminatory against GFAE equipment over that of CFE, for an impartial or specification standard is always used as a basis for rejection in all cases. One major airframe producer reported that he is attempting to determine whether GFAE or CFE items bear the higher rejection rate, but he is not yet able to report actual figures.

Leadman Quality Stamps

The psychological value of using leadman stamps for the control of workmanship was agreed as being of great importance. Issued to leadman or higher authority, stamp execution and control were designated to production management in all organization reporting, with the inspection department assigned the job of policing stamp execution and reporting the results to the management for action as required.

They may be called quality stamps, leadman stamps, or certification stamps, but, whatever they are called, they are used as a certification that parts and/or assemblies are complete to blueprint and specification requirements, with workmanship up to the normal quality standard of the organization, and that the order is actually ready for inspection. Quality stamps do not, however, ever supersede the inspection stamp.

Squawk returns are evaluated and reported in many different ways. In the small organizations, methods may be very simple but effective. Evaluation may be conducted direct from the squawk sheets, shop orders, and the like. Unsatisfactory quality stamp performances are referred directly to production management for corrective action. In larger organizations, the trend appears to be toward the use of statistical records and reports as a function completely separate from inspection. In regard to the effectiveness of stamp control programs on research and development contracts, it was said that the lack of production blueprints and tooling facilities common to most research and development contracts was not conducive to

the use of stamp control programs on this type of activity.

Source Inspection

It appeared that industry has many problems in attempting to obtain chemical and physical test reports for 100% of incoming raw materials. When purchases are for less than mill-run lots, statements or certificates to the effect that test reports are on file are commonly used throughout the industry. Representatives from the military services pointed out that statements or certificates of tests as defined in existing military contracts were not considered to be adequate objective evidence. Panel members reported that military specification MIL-Q-5923A was currently being debated for this issue by the AIA and the military services, and added their conviction that these debates would result in a solution to the industry's problems.

Reporting on the progress of the recently introduced automatic source inspection program, spokesmen for the military services stated that by surveillance methods they were currently handling a greatly increased work load to their total satisfaction. They commented on the fact that there was still some misunderstanding within the industry as to the automatic source program, and they pointed out that under this program it was not necessary to obtain prior approval of purchase orders in order to obtain AF inspection at the source, that all purchase orders placed with organizations listed as approved in the automatic source directory were automatically afforded AF inspection at the source; and that packing sheets on any material so procured would bear an AF inspection stamp from the source.

They further pointed out that, under Navy cognizance arrangements, Navy inspection was not yet operating under this program, but was considering it. In regard to which supersedes, the general Government procurement specification or the prime contractor process specification, where both are seemingly in effect at a given supplier's facility, it was said that the Air-Force-approved contractor's specification applies in any single instance. Moreover, AF inspection at the source is conducted for the convenience of the Government and basic responsibility for the delivered product rests with the prime contractor, in all cases.

The use of skids rather than boxes as a matter of mill practice in shipping of sheet alloy materials was discussed extensively. Major suppliers are using the skids as a result of considerable research and experience. It was reported that they were cheaper and resulted in a measurable reduction in the pounds of lumber per pound of material shipped. One major user of sheet stock materials reported that, on a one and one-half year's sheet-to-sheet record maintained at his facility, less than 5% of sheet materials received were diverted for structural uses due to surface damage. It appeared that condensation probably was more of a major problem than skin damage resulting from the use of skids, and that mill suppliers were attempting, through programs of interleaving and oiling plus proper ventilation, to effect cures for this latter problem.

One subcontractor reported that rejection rates within his plant were lowered from 16% to 5% as a result of introducing statistical quality control methods. He attributed the success of his application to the thoroughness of the initial educational program conducted throughout his entire organization, including the direct factory workers.

Invitations extended to all his vendors to cooperate in the program were also reported as an item of major assistance. Cumulative rejection reports were furnished on a monthly basis to all material suppliers and vendors being utilized by his materiel division, with excellent corrective action results.

A major airframe producer, who had long been a user of statistical quality control methods in his fabrication and machine shop areas, reported that he was now successfully using statistical quality control charts to control quality levels in his production structure and final assembly departments. He described how all production defects were catalogued within the range of previously determined classifications. The number of defects in each classification were summarized on a weekly basis, by department, for corrective action purposes.

Complete totalized figures are posted on a weekly basis on quality control line-graph charts within each department. These latter charts graphically picture the quality level currently in existence within the department. Because of these methods, the members of his organization are firm in their conviction that they are obtaining the maximum use of inspection information, inasmuch as both production and quality control managements are constantly aware of the quality level within all departments.

He further pointed out that the graphic presentation performed by these charts had proved that in the event of an out-of-control condition, the attention of management would be immediately directed to the necessity for corrective action measures. Also, that corrective action was found to be more effective if instigated while all factors requiring evaluation are still in existence.

In regard to the point of diminishing economical returns, it was reported that a specialized group, namely a producibility board, was assigned to study those cases where corrective measures indicated that quality control levels were too rigid or impractical relative to the article being produced. Their research, evaluation, and subsequent decision were then used to readjust quality control levels to the point of sound economics, as the occasion might demand.

Concerning control limits for the quantity allowed for any given type of classification of defect, or total allowable amount of defects in any one work area or department, it was said that the limits were basically established by past experience and specialized study of the article and/or the departmental function under consideration. The amount of past history and study required in establishing these limits varied with the circumstance. In some cases it could be simply done in a few days, in others six months, in other still additional time was required to establish an effective working quality control limit.

The control of rework time was reported to be

automatically included within the classification of defects.

Examples of the classification of defects relative to assembly departments were said to include defective rivets (AD., DD., Monel), other fasteners, mislocated parts and edge distance, gaps and cracks, process, functional, oversize hole, unauthorized rework, workmanship, completion stamps, chargebacks to other departments.

In conclusion, it was agreed that organizations with a low-level production output (having shop releases in the realm of one to five part release increments) would find it economically more sound to retain 100% inspection methods rather than to attempt to apply statistical quality control methods.

(The report on which this article is based is available in full in multilithographed form together with reports of the 10 other panel sessions of the 1952 SAE Aircraft Production Forum. This publication, SP-300, is available from the SAE Special Publications Department. Price: $2.00 to members; $4.00 to nonmembers.)

Turbine Engine Design . . .

. . . should reflect appreciation of maintenance problems. Such consideration will contribute substantially to engine reliability and economy in operation.

BASED ON PAPER BY **Marshall W. Galliers,** Wright Aeronautical Division, Curtiss-Wright Corp.

MANY factors must be taken into consideration when establishing a new engine design or modifying an old one. The well-balanced design should reflect each of these factors in proper proportion, such proportion to be determined by experience. Among the factors given most serious attention are durability and ease of maintenance for by no other means can the customer be assured of getting a powerplant which is both reliable and low in operating cost.

Operational experience with axial-flow turbo-jet engines reveals the necessity for inspection of compressor blades for damage from foreign objects. If minor blade damage can be repaired by maintenance procedures, we can expect operating time between overhauls to be extended substantially. Furthermore, "hot section" components require inspection and repair or replacement for burning, thermal distortion, cracking, blade and disc growth, fit of blade attachment, foreign object damage, and carbon accumulation.

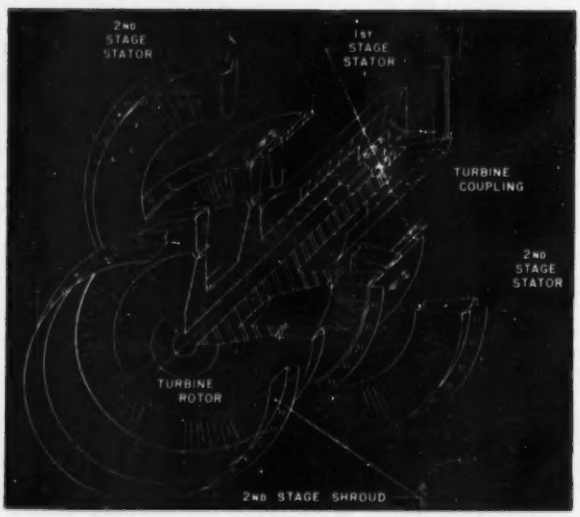


Fig. 1—Two-stage turbine design providing for ease of inspection and minor repairs in the field

Among designs which lend themselves particularly well to these maintenance requirements may be mentioned a compressor housing which comprises a stator housing of two halves assembled with bolts through the axial and circumferential end flanges. The design provides for the removal of all bolts without separating any parting surfaces. Either half of the stator housing is easily removed to permit full inspection of the compressor rotor and repair of minor blade damage by blending operations. Removal of both half cases alternately provides for inspection and repair of all stator blades.

Another design for easy maintenance is shown in Fig. 1. Here, easy field inspection and repair is provided for a two-stage turbine. Removal of the engine exhaust cone affords a clear view of the trailing portion of the second-stage rotor blades, and blade tip to shroud clearance can be measured easily. A line of vision chordwise between the second stage rotor blades gives a view of the second stage stator blade trailing edges. Upon removal of the second stage rotor shroud and stator assemblies in 180 deg segment, diagonal vision between the two rotor blade rows gives a view of the first stage rotor blades, with easy measurement of blade tip to shroud clearance.

Again, vision chordwise between first-stage rotor blades affords a view of first-stage stator blades. First-stage rotor shroud and first-stage stator assembly can be removed following removal of the turbine rotor assembly, which is retained by a single nut. However, turbine rotor blades can be replaced without removal of the complete turbine rotor from the engine. (Paper "Maintenance Considerations in Design" was presented at SAE Annual Meeting, Detroit, Jan. 15, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

1951

CRC CAR OCTANE SURVEY LAUNCHES NEW FOUR-YEAR PLAN

MANY consider the octane number requirement surveys one of the most important contributions made by CRC. The information given by these surveys could only be done cooperatively by many laboratories, and would be too costly a project for any one company.

For the petroleum industry, the survey helps establish necessary levels of gasoline quality.

For the automotive industry, the survey offers each company a basis for comparing its own cars with all the others on the road.

Results of CRC's 1951 Survey recently have been published and made available through SAE. The '51 Survey is particularly significant because it kicks off the first part of a four-year integrated program aimed at providing a more useful service with less test time spent in accumulating data.

In the survey, 450 cars of all makes were tested by 26 laboratories. Of these cars, 120 were designated "control" cars (which will be discussed later), 77 were designated "new design," and 97 (for which the manufacturer recommended premium gasoline) were designated "high requirement."

Highlights of the results are shown in the charts accompanying this article.

For example, Fig. 1 compares the distribution curve of maximum octane requirements of both the 1949 and 1951 Survey cars. The two curves are practically identical.

Distribution of maximum requirements by geographical areas is shown in Fig. 2. The proportion of the different makes and models tested in the East, Central and Western areas of the country was about the same.

Requirements for individual make cars are shown in Fig. 3. The 10% and 90% satisfied points were chosen instead of minimum and maximum values. Extreme limits of the distribution curves are generally inaccurate. Variations in requirements between makes of cars are as follows: (a) a maximum of 16 octane numbers for 10% satisfied, (b) 12 octane numbers for 50% satisfied, and (c) 10 octane numbers for 90% satisfied. Differences in requirements between the 10% and 90% points for cars of the same make range from a minimum of 7 octane numbers for cars B and G to a maximum of 18 numbers for car A.

Distribution curve of maximum requirements for the 450 cars with three type fuels are shown in Fig. 4. They are primary and severity reference fuels and commercial type gasolines. A comparison of these results with those of the 1949 Survey indicate a change. The relative positions of the curves for the severity and commercial type fuels are reversed in the range from 40% satisfied to the upper limits of the curves.

Note also that, for example, it takes a commercial type gasoline of about 88 octane number and a primary reference fuel of only about 86 octane number.

Fig. 5 summarizes the engine speeds at which maximum knock occurred with the three sets of fuels. It occurred most often with all three type fuels in the speed range between 750 and 1400 rpm. It is interesting to note that 29% of the cars had maximum requirements above 1400 rpm, while only 22% were in this range in the 1949 Survey.

It also is interesting to note that in this survey, as in others, about 36% of the owners reported their cars are knocking.

For its '51 Survey, the Equipment Survey Group of CRC's Motor Fuels Division set up a three-part octane requirement program:

1. A statistical survey of postwar cars according to national registration figures. (This was done to bring up-to-date information accumulated in the '49 Survey.)

2. A study of the effect of new engine and transmission designs and high requirement cars. (Any significant change in octane need brought about by such design features could more easily be detected this way.)

3. An investigation of the change in cars of a given model year or years with accumulated age or mileage. (Purpose here was to spot the nature and extent of re-

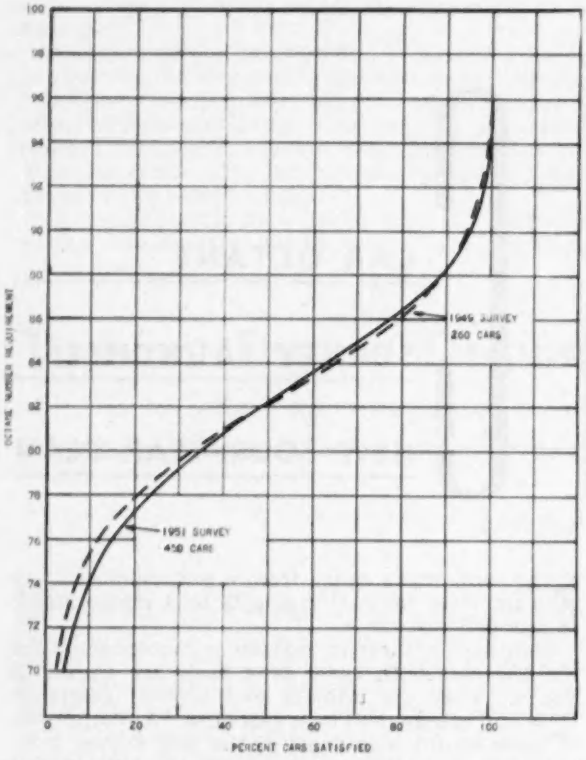


Fig. 1—Maximum octane requirements for the 450 cars in the 1951 Survey were almost the same as those for the 260 cars in the 1949 Survey

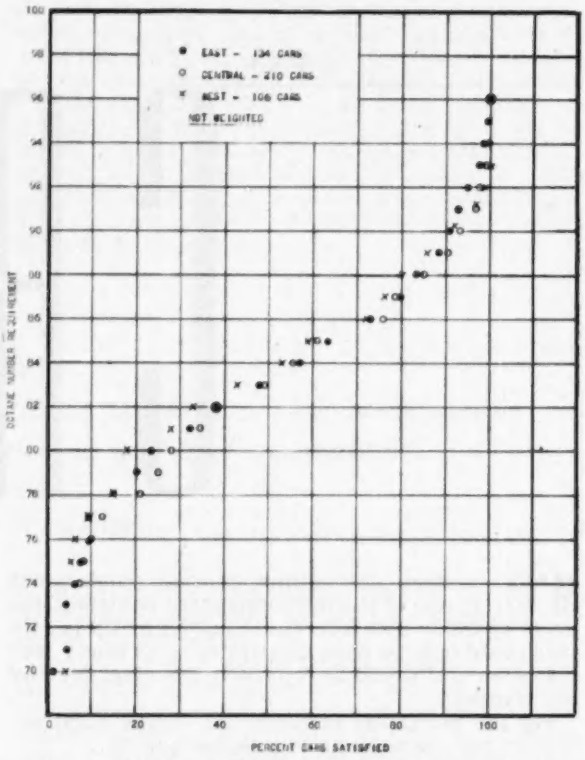


Fig. 2—These data show distribution of maximum octane requirements by geographical areas

quirement change with age and use. If this could be done for a number of models, it might be possible to estimate changes in requirements after determining new car requirements.)

The Equipment Survey Group hoped that this program would help it synthesize distribution curves for at least two years rather than to conduct a conventional statistical survey each year. Here's why:

Three main factors are responsible for year-to-year changes in octane number requirement distribution curves: (1) scrapping of old cars, (2) changes in requirements of cars in service, and (3) addition of new cars. Since scrapped cars average about 10 years in age, they're at the low end of the distribution curve and are of little importance to most labs. So if basic data could be adjusted for requirement changes of cars in service and addition of new cars, accurate distribution curves could be synthesized for at least two years after a statistical survey.

To study changes in requirements of cars in service, it was planned to select four or five car makes of specific model years. These would be the "control cars." By testing these "control cars" for several years, effect of age on their requirement level could be found. These changes could be applied to a statistical curve gotten earlier.

So the Equipment Survey Group used this thinking in building a long-range cooperative program for the years 1951-1954.

It was planned as follows:

- In 1951, conduct a statistical survey as a base line plus simultaneous work on the control car and new design phases.
- 1952 and 1953 should be devoted to continued work on the control car and more extensive testing of new designs.
- In 1954, the statistical survey will be repeated while the control cars will be continued.

Right now it looks as if the "control car" concept won't work. That's because not all vehicles change with age in the same way, the '51 Survey showed.

The report was prepared by an Analysis Panel composed of: H. J. Gibson, Ethyl Corp., leader; H. W. Best, Yale; H. A. Bigley, Jr., Gulf Research & Development; W. P. Dugan, Sun Oil Co.; J. C. Ellis, Shell Oil Co.; G. E. Onishi, Studebaker; R. L. Porter, Standard Oil Co. (Indiana); L. Raymond, Socony-Vacuum Laboratories; R. Rhode, Phillips Petroleum; L. J. Test, Atlantic Refining; R. K. Williams, L. L. Withrow, Research Laboratories Division, GMC.

The report, "Octane Number Requirement Survey, 1951," CRC-266, contains 154 pages including 31 charts and eight tables. It is available from the SAE Special Publications Department. Price: $5.00 to members, $10.00 to nonmembers.

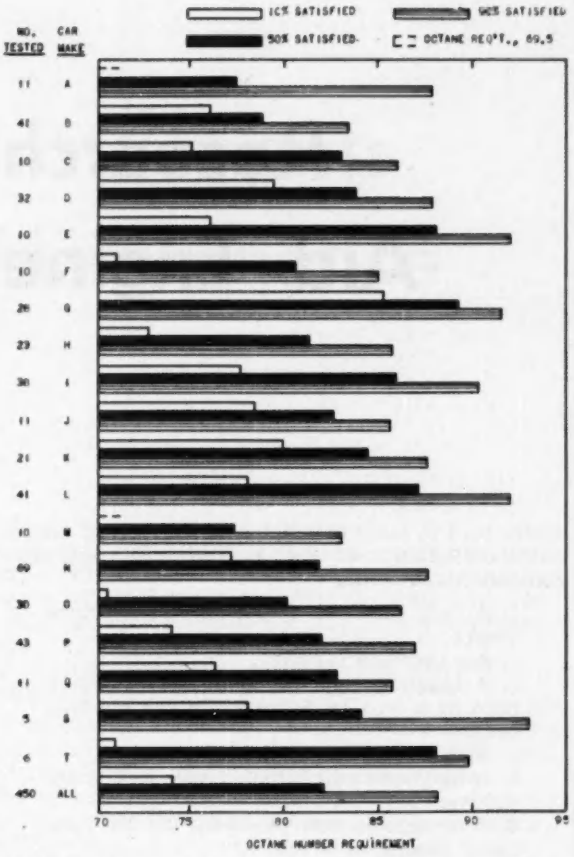


Fig. 3—Individual car makes showed variations in octane requirement. Even cars of the same make differed in octane requirements

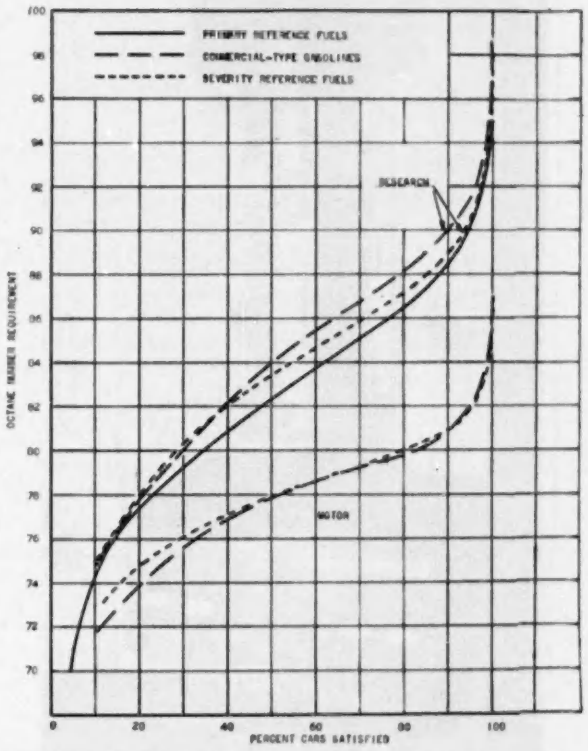


Fig. 4—Distribution of maximum requirements with primary and severity reference fuels and commercial type gasolines

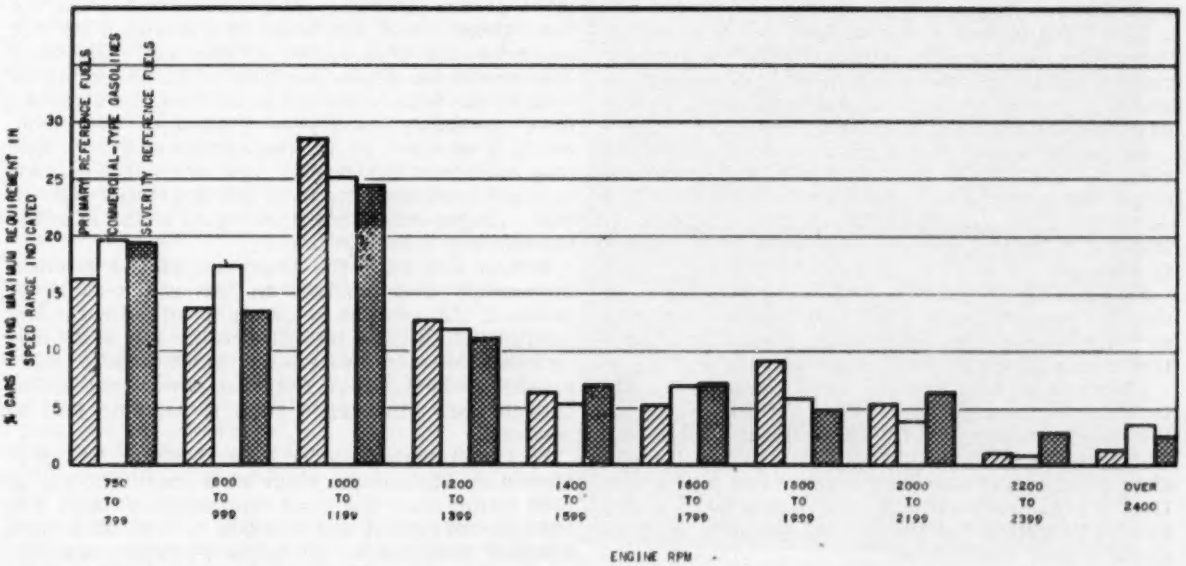


Fig. 5—These data on engine speeds at which maximum knock occurred with the three type fuels show that it happened most often between 750 and 1400 rpm

Research Aid Engine

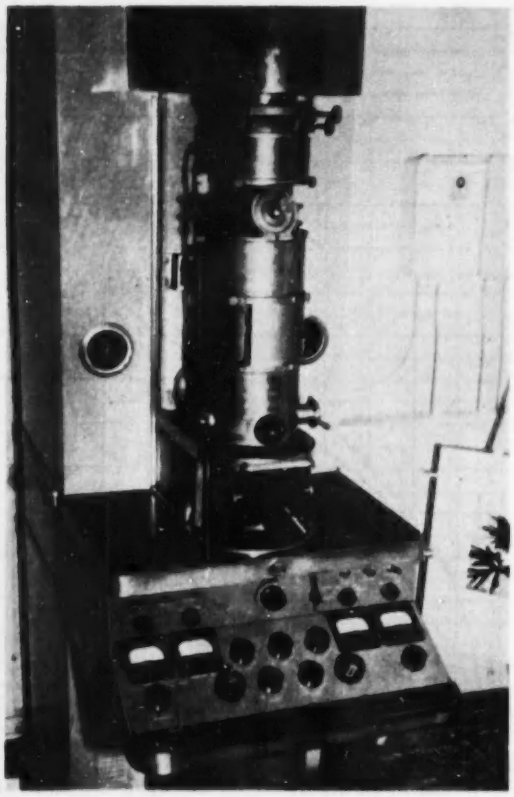


Fig. 1—RCA electron microscope (from Broughten)

NEW techniques are making both the electron microscope and the spectrograph valuable tools in oil research and manufacture and in the engine maintenance field.

The electron microscope, in particular, is aiding lubricating oil research by contributing to a better understanding of the mechanisms of such phenomena as detergency and oxidation and to the development of better additives.

By studying the dispersancy pattern of the oil with the microscope, manufacturers and users can determine whether or not the additives used in the oil were of the proper purity—a fact that has an important bearing on the performance of the oil in service.

By analyzing crankcase oil samples with both the electron microscope and the spectrograph, maintenance engineers can learn much about the condition of the oil and, indirectly, of the engine itself.

They can be used to warn when the oil needs attention because of (1) loss of additive, (2) containing contaminants, or (3) breakdown of the oil. This analysis of the oil also indicates when the engine needs attention—and often even where the trouble lies. It can thus be used to forestall major engine breakdowns without the necessity for frequent engine inspections.

The RCA electron microscope shown in Fig. 1 was used in the studies reported by Broughten. It operates on the same principles as the optical microscope, as shown in Fig. 2. Its basic operating components include:

1. A hot filament (cathode) or electron source.
2. An aperture (anode).
3. A magnetic coil or condenser, which is used as a lens to concentrate the electron beam.
4. The sample stage.
5. A magnetic coil, which serves as the objective.
6. A magnetic coil projector of the primary image.
7. A fluoroscope screen for viewing or a photographic plate for photographing the magnified image.

The microscope housing is evacuated to a pressure of about 10^{-5} mm of Hg to permit free movement of the electrons that are emitted from the hot cathode, and refraction is controlled by the magnetic coil that serves as the lens. Electrons that encounter dense particles, such as carbon or soot, in the sample are either deflected or absorbed from the beam, causing a shadow in the beam, which is observed on the fluoroscope as a dark spot magnified 1500–8000 times. As a result, it is possible to study particles only 50–10,000 Angstrom units in size. (10,000 Angstrom units equal about 1/10 the thickness of a human hair.)

It was not until the invention of the electron microscope that particles in this range could be resolved. (Resolution is the ability of a magnifying instrument to show minute detail, such as to distinguish between two points infinitesimally separated.) It is this high resolving power that makes the electron microscope such a valuable tool of research.

In the Broughten study, the specimen was first viewed on the sample stage at a magnification of 1500 diameters. The most representative area was then photographed and enlarged to 6750 diameters. Further enlargement to 45,000 diameters was accomplished by the usual photographic techniques.

The electron microscope is particularly adapted

Instruments Maintenance

Based on papers:

An Electron Looks at Detergent Oils

by J. L. Broughten

Union Oil Co. of Calif.

Practical Use of Spectrograph and Electron Microscope for Study of Diesel Engine Conditions

by Ray McBrian and L. C. Atchison

Denver & Rio Grande Western Railroad Co.

Diesel Maintenance Control by Spectrographic Means

by H. R. Sennstrom

American Locomotive Co.

These papers were presented at SAE National Diesel Engine Meeting, St. Louis, Oct. 30, 1952.

to the study of the macromolecular organization and activity of matter. This is the range in which most of the important reactions of lubricating oils in engines, such as oxidation and detergency, take place.

Broughten used the electron microscope to investigate the following phenomena:

1. Solubility of various commercially available oxidation-corrosion inhibitors and detergents in well-refined base oils of different compositions.
2. Dispersive effect of these additives on nonactivated carbon black that has been dispersed in the additive-oil mixture with an homogenizer.
3. Oxidation stability of lubricating oil in the presence and absence of oxidation-corrosion inhibitors and dispersant compounds.

Solubility—One of the prime functions of a compounded oil is to minimize the undesirable effects of engine sludge, which is composed mainly of carbonaceous matter, soot, and oxidation products. This can be accomplished by utilizing either an additive that inhibits sludge formation or one that disperses the sludge after it forms. In both cases, a high degree of surface activity is required.

Since solubility is believed to be largely a function of surface activity, it is highly desirable to know the relative solubility as well as the surface activity of each of the additives in the base oil.

The relative solubilities can be determined from electromicrographs, such as shown in Fig. 3 for two commercially available detergent additives in an 18 V.I. base oil.

The effect of the difference in the solubilities of these two additives on their dispersant qualities is not entirely clear. The more soluble additive was, however, more effective with respect to engine detergency and dispersancy.

The electron microscope also allows us to study relative solubilities of additives in base oils of different compositions.

It has been contended that additives are more effective in base oils of lower V.I. The initial studies made by Broughten do not entirely substantiate this statement. It might, for instance, be

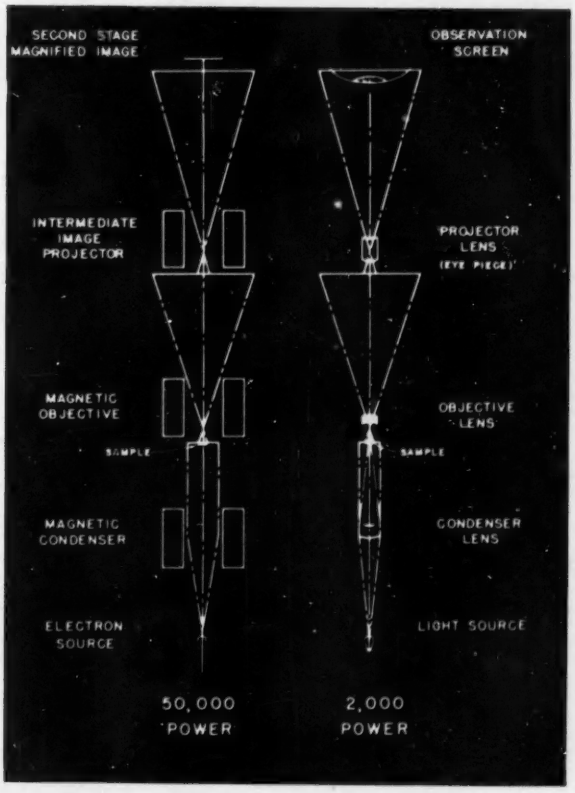


Fig. 2—Diagrammatic comparison of electron microscope (left) with light microscope (from Broughten)

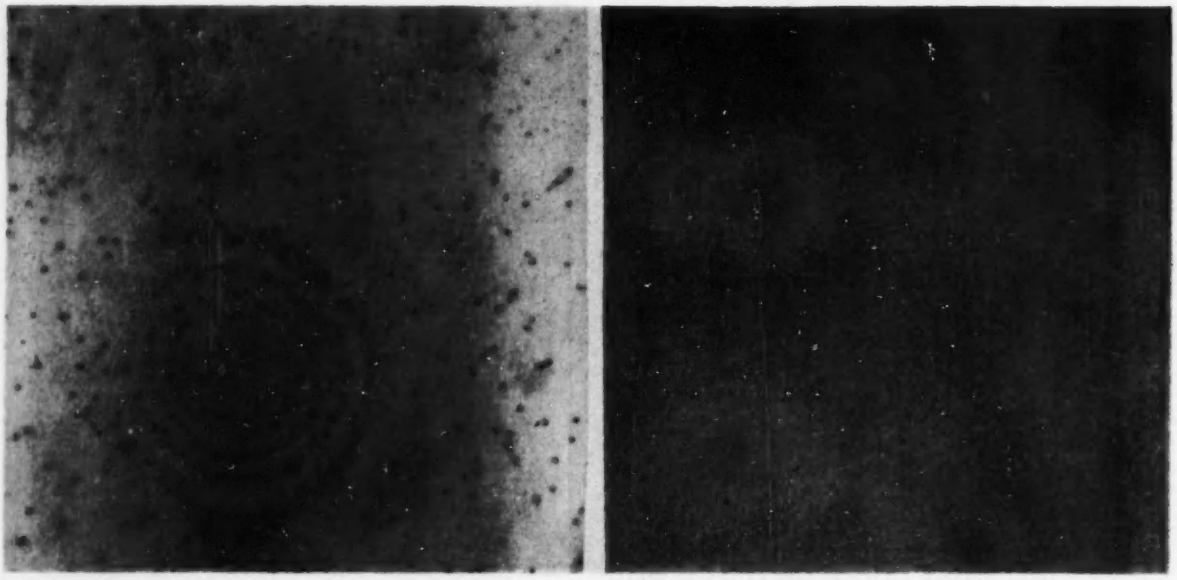


Fig. 3—Electromicrographs showing relative solubilities of two commercially available detergent additives in 18 V.I. base oil (from Broughton)

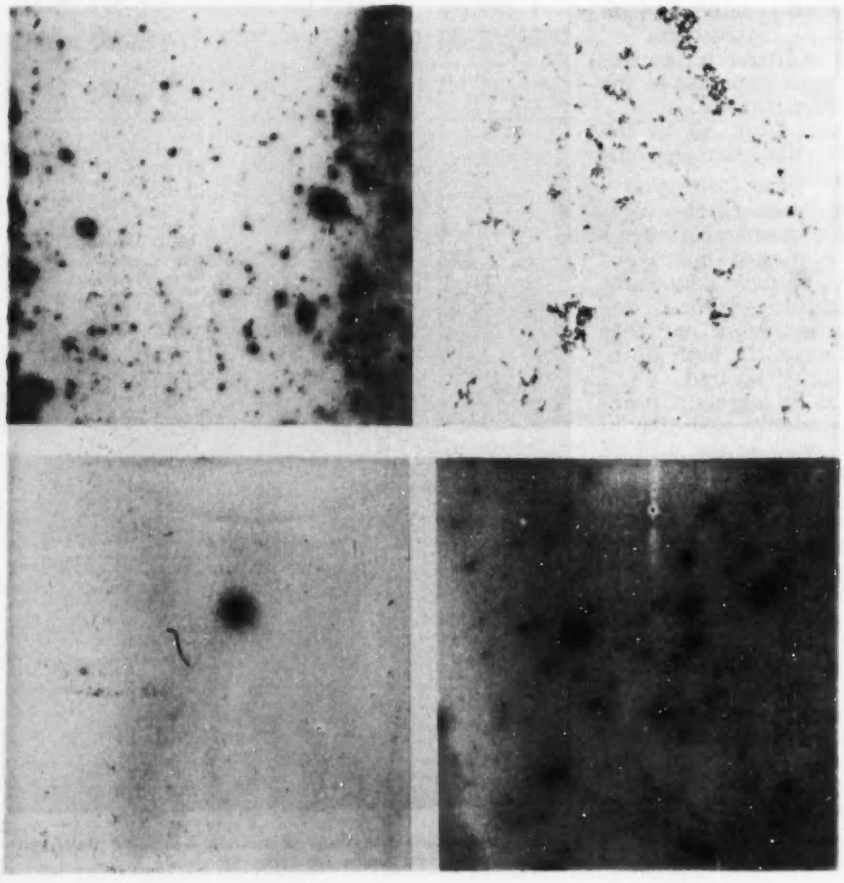


Fig. 4 — Electromicrographs showing change in used oil taken from railroad diesel engine at various mileages. Upper left: 10,000 miles; upper right: 30,000 miles; lower left: 70,000 miles; lower right: 75,000 miles (from Broughten)

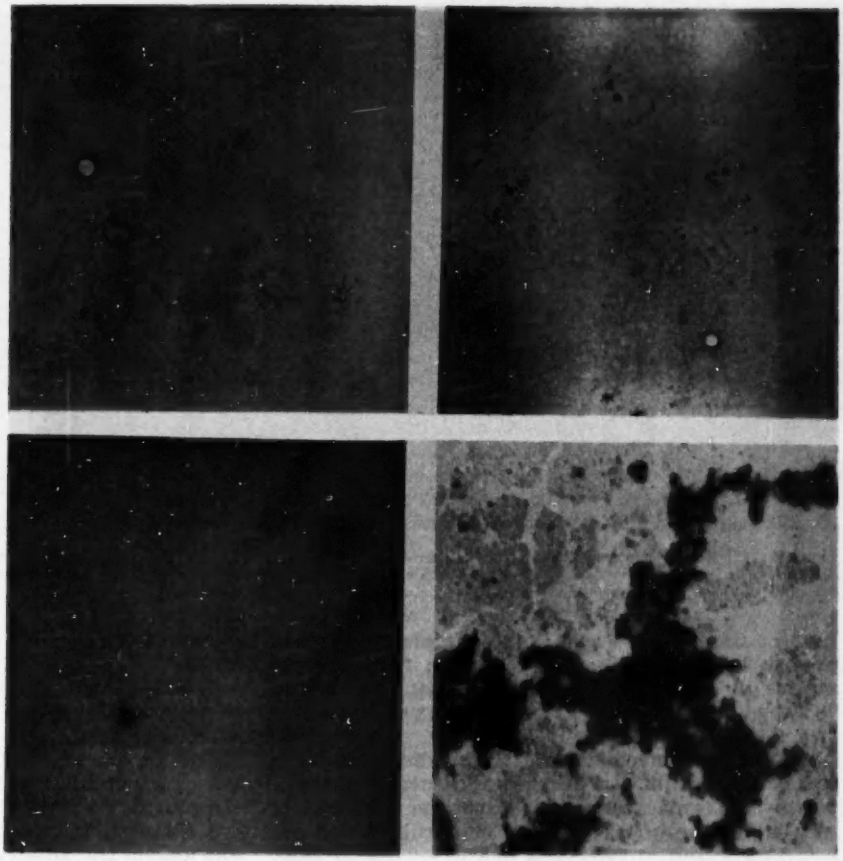


Fig. 5 — Electromicrographs showing effective oxidation inhibition of two additives in 58 V.I. base oils containing 0.3% homogenized carbon black. Upper views: oil before heating; lower views: after heating for 157 hr (from Broughten)

considered anomalous that a mixture of naphthenic (18 V.I.) and paraffinic (85 V.I.) base oils would show a higher solvency than either of them alone.

Based on the solubility studies of numerous additives, it is indicated that the solubility equilibrium of most additives is maintained very near the point of maximum solubility. This fact permits the identification of insoluble additives.

Dispersancy—The suspension of soot, carbonaceous matter, and oxidized particles of colloidal size in lubricating oils establishes a heterogeneous system in which solid-liquid interfaces exist. Lubricating oils are nonionizing solvents and the forces that colloidal dirt particles in used oils exert on one another are always attractive, so the particles tend to coalesce.

It has been shown that physical and chemical forces control the state of matter in any heterogeneous system, and therefore these forces dictate the degree of stability of the system. In noncompounded oils containing dirt particles of colloidal size, the interparticle attraction and gravitational forces result in the flocculation of these macroparticles.

Utilization of dispersant or deflocculating additives alters the chemical and physical conditions and prevents the dirt particles from contacting each other. More specifically, the relative surface tension is modified so that the attractive force between particles is less than that between the particle surface and the additive-oil molecules.

This alteration is not widely understood. It is, however, generally accepted that used engine oil contaminants, such as soot and carbon, are associated with oxidation products (carboxyl, hydroxyl, and keto groups) to which the dispersant additive becomes attached, adsorbed, and oriented, due to their polar character. This action reduces the interfacial tension and thereby reduces the attractive forces of the particles.

The deflocculative actions of various detergent compounds are not the same nor are the dispersive powers of any one additive the same in various base oils.

It is true that the light microscope or, for that matter, volumetric sedimentation readings, can give a rough measurement of dispersancy. The electron microscope is, however, a much more versatile instrument, according to Broughten. It can be used to study particle size, shape, and structure, as well as particle orientation—and at magnifications far beyond those possible with the light microscope.

It can be used, he adds, to study the relationship of additive concentration to dispersive action. With the extensive utilization of additive oils, it is important to be able to estimate the dispersive qual-

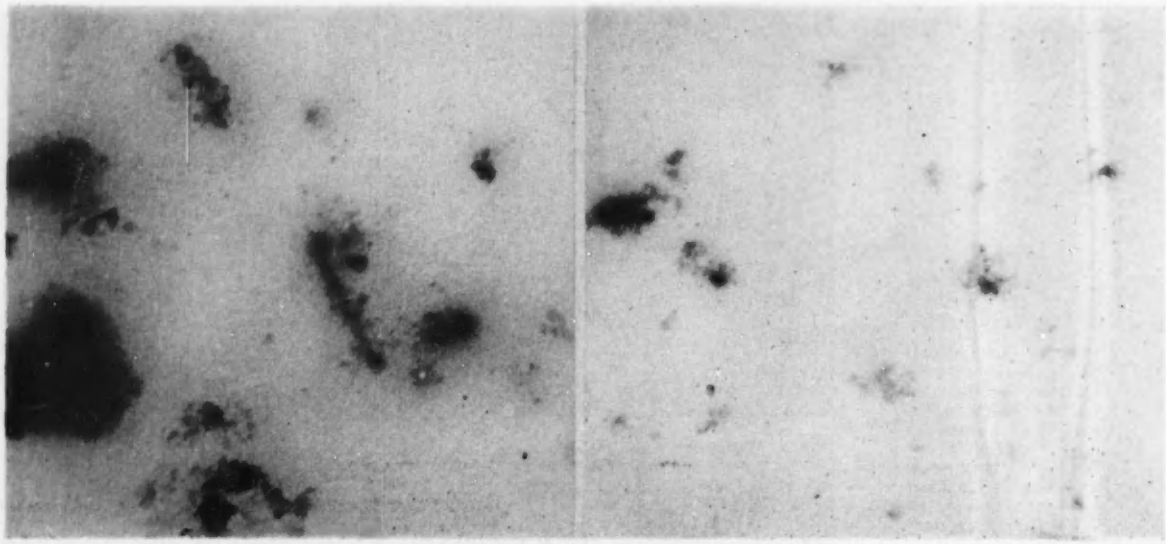


Fig. 6—Left: lamellar pattern of oil containing calcium-base additive, after 281,000 miles; right: micellar pattern of oil containing calcium-zinc additive, after unknown amount of mileage (from McBrian and Atchison)

ities of used oils. Fig. 4, for example, shows the progressive change in used oil taken from a locomotive diesel engine at 10,000, 30,000, 70,000, and 75,000 miles, with the barium content of the oil at 0.25, 0.16, 0.10, and 0.22%, respectively.

As the barium concentration in the used oil is reduced, the ability to suspend or disperse contaminants is likewise reduced. With the addition of new oil to the crankcase, the sludge particles are again dispersed, but perhaps to a lesser degree than by the new oil in a new engine.

Oxidation Stability—According to Broughten, the electron microscope has also been found to be extremely useful in studying base oils under oxidizing conditions, principally because the oxidation particles, such as polymers, resins, and oxyacids, can be readily identified and distinguished from other contaminants.

One can also study the effective oxidation inhibition of various additives. Fig. 5 shows two oxidation inhibitors in 58 V.I. base oils containing 0.3% homogenized carbon black before and after being heated in the oven at 210 F for 66 hr. Note that with the additive used in the oil at right there was appreciably more resinous (mottled appearing) material after 157 hr than for the other additive-oil combination.

Practical Use of Electron Microscope

A practical study of both new and used diesel-engine lubricating oils was undertaken by McBrian and Atchison. Their studies of crankcase oil samples covered most of the modern makes of diesels from small horsepower units to 2000-hp railroad units.

Although their work is still in a more or less preliminary stage, they feel that the following conclusions can be expressed concerning crankcase oil:

1. A stable straight mineral oil reveals no pattern unless contaminants are present, when studied under the electron microscope at magnifications up to 45,000.

2. Diesel engine lubricating oils containing detergent additives are colloidal suspensions rather than true solutions. Each additive has a definite structure, the pattern usually being lamellar, micellar, or a combination of both lamellar and micellar structures.

3. Base stock solvency as related to viscosity index affects the additive pattern; oils with the most uniform dispersancy pattern have the best overall service records. (Moreover, the medium viscosity index oils—50–60 V.I.—with an additive from the alkaline earth group give the best overall dispersion and the best service results.)

4. The structure and pattern of dispersion in the detergent-additive lubricating oil determines the pattern in which dirt, carbon, and the like remain grouped in the used oil in the crankcase, and the pattern or grouping tendency appears to influence the rate of wear, lacquering, deposits, and amount of ring breakage.

5. New, unused additive oils can have their normal dispersion pattern completely changed through residual impurities in either the base oil or the additive. Similarly, can used oils—through the introduction of oxidizing agents as contaminants—lose their capacity for dispersion. Also, a breakdown of the used oil in service changes the additive pattern.

The basic fact that new, unused lubricating oils containing additives are colloidal suspensions has not been fully understood and its significance realized. For instance, the pattern or type of colloidal suspension dispersancy is important in determining how well an oil performs in service. Its existance is also responsible for many hitherto mysterious observations, such as that:

1. Additive oils cannot be mixed.
2. Base stock solvency is important.
3. Additive depletion can occur.

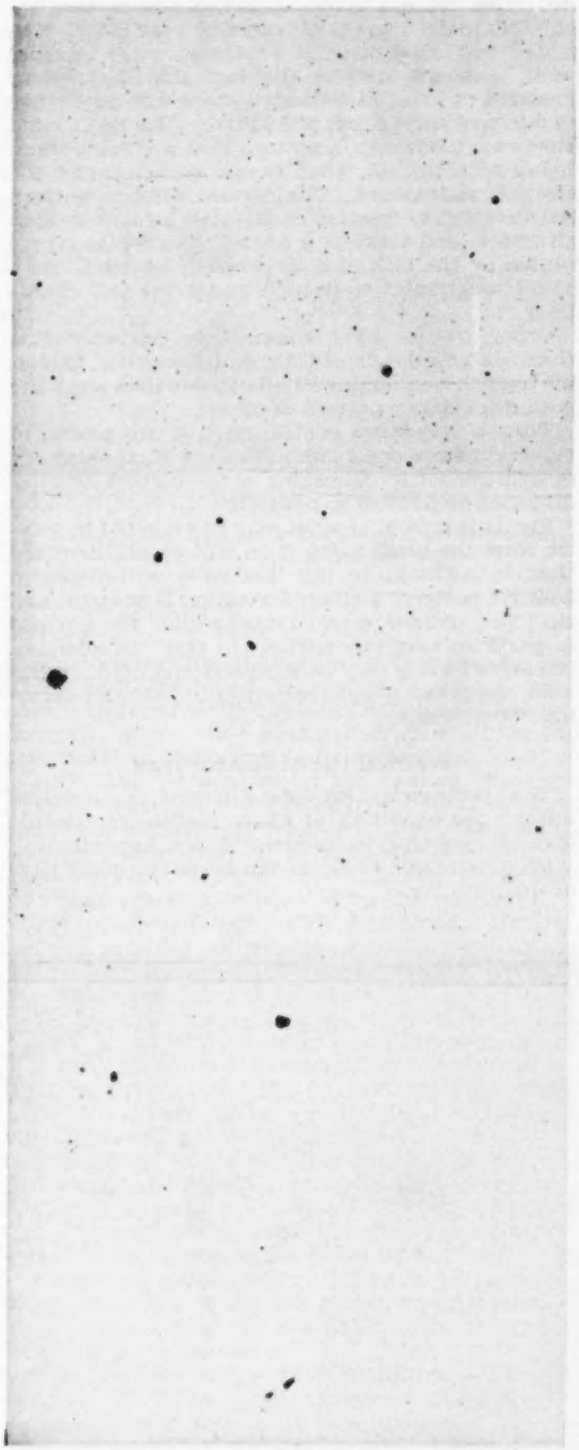


Fig. 7—Electron micrographs showing effect of variation in viscosity index on dispersancy pattern of new oils. Upper view: pattern is fine and well dispersed with oil of 57 V.I., containing barium-potassium additive; middle view: pattern is poor with oil of 74 V.I., containing same additive; lower view: almost complete lack of dispersancy pattern with oil of 81 V.I., containing barium-zinc additive (from McBrian and Atchison)

4. Oil shipments with the same apparent additives may give entirely different results in service.

Fig. 6 shows electron micrographs (taken at 45,000 magnifications) of new oils containing additives that give lamellar and micellar patterns.

Fig. 7 shows the effect of a variation in viscosity index on the dispersancy pattern of new oils.

Fig. 7A is for an oil of 57 V.I., containing barium-potassium additive. Note the fine, well-dispersed pattern—averaging less than 1/10 micron in size.

Fig. 7B is for an oil containing the same additive but with a V.I. of 74. This oil has a much poorer overall dispersancy pattern.

Fig. 7C is for an oil of 81 V.I., containing a barium-zinc additive. Note the almost complete lack of a dispersancy pattern.

Extensive 500-hr field tests with GM 271 diesels actually confirmed the fact that the only satisfactory oil in this group was the one with the 57 V.I. The oils of higher viscosity index had higher wear rates and higher consumption in these tests. (Spectrographic analyses also confirmed these findings.)

The relation of the dispersancy pattern of an oil in service to the size of the collected contaminants is considered important. Note in Fig. 8 the fine particle size of the contaminants in the medium viscosity oil containing a calcium additive after 15 weeks of operation. With the oil containing this type of a calcium-zinc additive (Fig. 9), on the other hand, there is a tendency for the contaminants to collect into particles of more than one micron in size.

This latter figure illustrates the poor dispersancy and the grouping of dirt plus additive to particles of over one micron in size, which, it is felt by Mc-

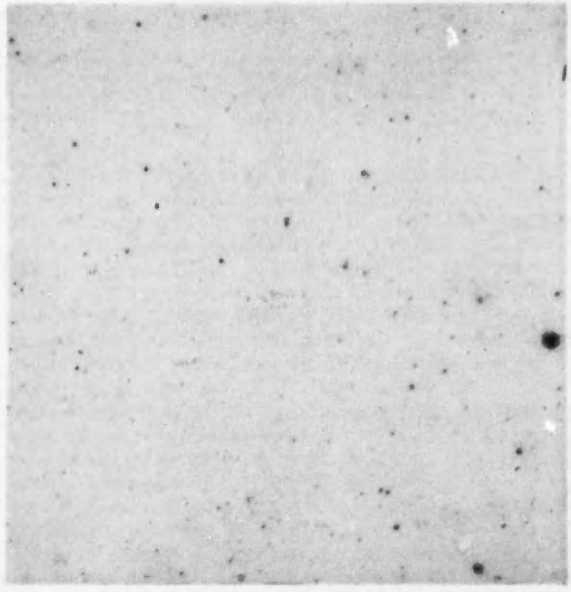


Fig. 8—Contaminants are finely dispersed in this used oil of medium viscosity, containing calcium additive, after 15 weeks of operation (reduced from micrographs taken at 6750x) (from McBrian and Atchison)

Brian and Atchison, can result in ring breakage, edge wear, and bald spot wear on rings without forming a permanent deposit. (Actual spectrographic analyses and wear figures confirmed these findings.)

To secure good wear results, it is their belief that we must maintain at all times during the life of the oil in the engine a fine dispersion of additive plus contaminants of less than ½ micron in size.

Fig. 10 shows how minute residual impurities in additive manufacture can affect the additive pattern in a new oil. The left hand view shows the additive dispersancy pattern in a new calcium-base oil. This oil has given excellent service test results for many years, with very low wear rates. Yet, under test conditions, it presented some unusual wear problems, despite the fact that all regiuar methods of analysis indicated there was no change of additive and no loss of additive. The right hand view shows, however, a pattern that was some times found with this oil, when it was studied under the electron microscope. The normal additive pattern has reverted to calcium chain-type greases or soap structure, and there is a loss of additive as represented by the lack of a dispersancy pattern. As a result, wear rates were high under the test conditions.

Other studies have shown how contamination from such materials as fatty acids, caustics, oxidizing agents, and mixing of additives will destroy the good dispersancy pattern of an oil.

Thus, a very quick control method can consist of making microscope examinations of each shipment of additive oil to determine if the correct additive dispersancy pattern is present.

Fig. 11 is typical of what may be expected in service from the breakdown of an oil. It will be noted that, in addition to the lack of a well-dispersed additive pattern, a chain formation is present, and that the additive plus contamination are grouped in particles over two microns in size. In addition, the areas having very dark centers and light, graduated, shadowed fringes are typical of lacquer-forming constituents.

Fig. 9—Contaminants have tended to collect into particles of more than one micron in size in this used oil of 85 V.I., containing calcium-zinc additive, after 15,752 miles of operation (reduced from micrographs taken at 45,000x) (from McBrian and Atchison)

Practical Use of Spectrograph

The spectrograph provides a technique for determining the condition of many engine components without resorting to frequent engine inspections.

Spectrographic analysis can be either qualitative or quantitative.

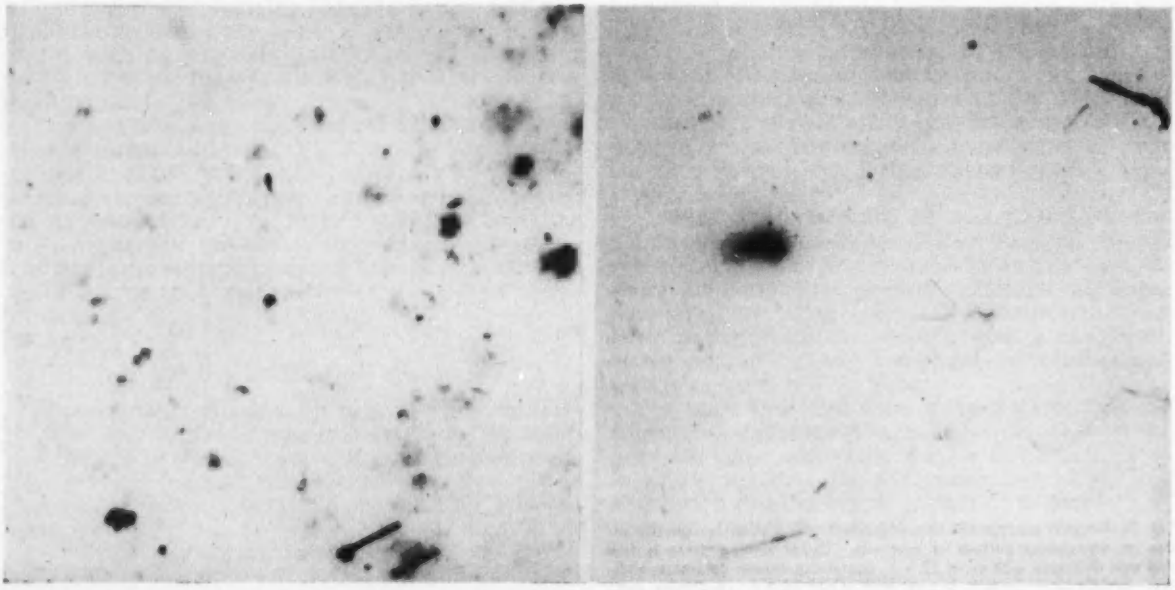


Fig. 10—Left: additive dispersancy pattern of new calcium-base oil that gave excellent service results; right: impurities have made the additive pattern of the oil revert to calcium-chain-type greases or soap structure, giving high wear rates under test conditions (reduced from micrographs taken at 45,000x) (from McBrian and Atchison)

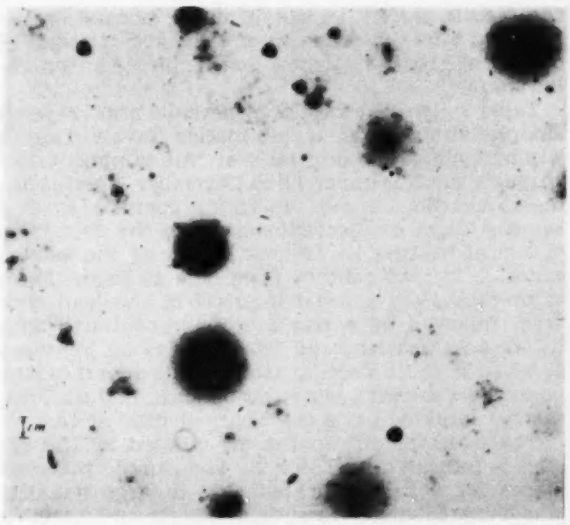


Fig. 11—Lack of well-dispersed additive pattern in oil that has broken down in service (from McBrian and Atchison)

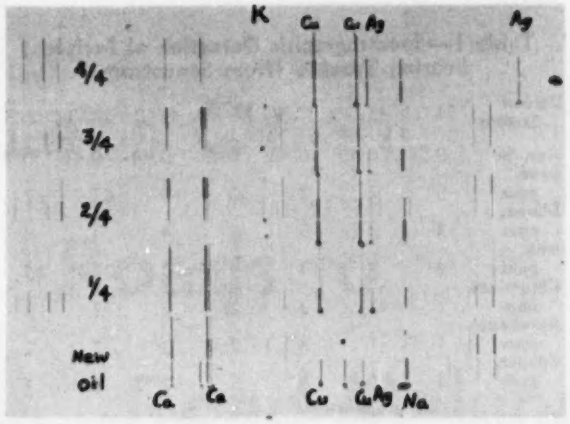


Fig. 12—Spectrograms for used oil when silver wristpin bushings are used. ¼ marking shows satisfactory amount of silver; 4/4 marking shows high amount of silver, indicating excessive wear (from McBrian and Atchison)

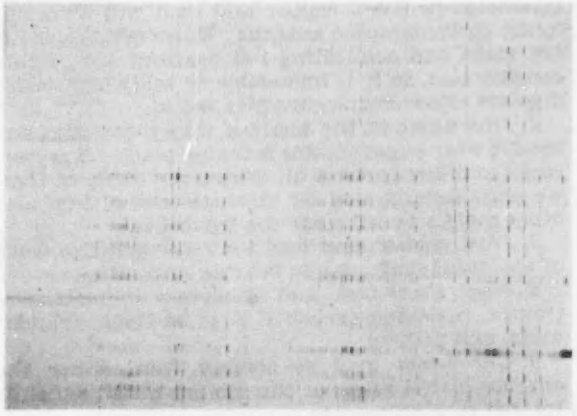


Fig. 13—Spectrograms illustrating engine conditions when air and oil filter maintenance are being handled correctly (upper spectrogram) and incorrectly (lower spectrogram) (from McBrian and Atchison)

With the qualitative method, as described by McBrian and Atchison, it is possible to get a general idea of what is occurring in a particular diesel engine operation. Any metals that show up in the spectrogram that were not present as additive metals—and by analysis of the new oil shipment finding that the oil is relatively free of residual metals as impurities—must come from the engine, generally through wear. A knowledge of what these metals are can then give some indication of the type of trouble present or brewing in the engine.

For instance, if such metals as tin, lead, cadmium, copper, or silver are present—and the bearings are made from some of these metals—their presence usually indicates bearing trouble.

On the other hand, if silicon, titanium, and magnesium are present, air filter maintenance problems are usually to be anticipated. When chromium, iron, aluminum, and the like are used for rings, pistons, and liners, the presence of these metals usually indicates out-of-line conditions.

Figs. 12 and 13 are spectrograms of crankcase oils from engines operating under typical conditions.

The ¼ marking in Fig. 12 shows the spectrogram for a lube oil containing a satisfactory amount of silver when silver wristpin bushings are used. The 4/4 marking shows what happens to the spectrogram when the wristpin bushing is wearing at a high rate—so that the allowable limit of wear is reached in 100,000 miles.

Fig. 13 illustrates engine conditions when the air and oil filter maintenance and changes are being correctly and incorrectly handled. The upper spectrogram is for the correctly handled program. The lower one illustrates—for the same engine—the high wear conditions arising from unduly extending the air and oil filter life.

Sennstrom showed that the analyses can be made quantitative, if desired, by mixing an internal standard with the ash of the oil being analyzed. Since the standard must be an element not normally present in the oil, he uses lithium—in the form of lithium carbonate. Thus, on each spectrogram, one of the emmision lines is that of lithium. Next, he uses a densitometer to determine the densities of all lines of interest, in relation to the density of the lithium line. Since the amount of lithium in the sample is known, he can calculate the amount of each element appearing in the sample, stated in parts per million (ppm).

He found that under normal operation the crankcase oil of the model 244, 12-cyl, 9×10½-in. locomotive diesel engine he studied contained the following amounts of important metals: 10 ppm lead, 6 ppm silicon, 20 ppm iron, 5 ppm chromium, 3 ppm aluminum, and 4 ppm copper.

When, on the other hand, excessive amounts of one or more of these metals are present, he found that certain troubles were in the making, such as:

1. *Lead* and *copper* indicate bearing difficulties. The bearings in these engines consist of a steel back,

Table 1—Spectrographic Detection of Incipient Bearing Trouble (from Sennstrom)

Date of Sample	11/11	11/25	12/9	12/23	1/10	1/20	2/8
Ash, %	0.53	0.48	0.44	0.43	0.44	0.41	0.42
Lead, ppm	5	2	2	10	11	62	82
Silicon, ppm	8	3	3	6	4	4	3
Iron, ppm	13	6	14	15	40	29	25
Chromium, ppm	1	1	2	2	2	2	2
Aluminum, ppm	1	1	3	2	3	2	2
Copper, ppm	2	3	3	5	5	8	13

a copper-lead intermediate layer, and an overlay of lead-tin babbitt. If the crankshaft wears through the overlay and starts operating on the copper-lead intermediate layer, copper and lead will show up in the spectrographic analysis. Unfortunately, both the main and connecting-rod bearings are of this construction, so it is impossible to tell which bearings are experiencing excessive wear.

2. *Iron* alone in the analysis may mean that excessive wear of gear trains is taking place. However, since so many parts of an engine are made of iron, we must usually look for combinations of iron and other metals to tell what the trouble is.

3. *Iron, copper,* and *lead* indicate excessive wear of the crankshaft, due to bearing difficulties.

4. *Iron, chromium,* and *aluminum* indicate ring trouble, involving excessive wear of rings, cylinder walls, and pistons.

5. *Chromium* may be coming from either the chrome-plated liners or the cooling water, which is treated with chromates.

6. *Aluminum* indicates wear or scoring of the aluminum pistons.

7. *Silicon* is generally considered the best indicator of dirt—particularly airborne dirt. In a diesel, dirt is most apt to enter through the air breather, and the quantity of dirt is dependent on the quality of the air filter maintenance. Since a considerable amount of sand is used in locomotive operation, sand and silicon dioxid are most commonly found in the oil.

Tables 1 and 2 show the case histories of two locomotive engines and illustrate the amounts of the metals present in the oil under normal operation and how the presence of excessive amounts of certain elements may show up to indicate a particular trouble.

Table 1 gives the results of periodic crankcase oil sample analyses of a locomotive involved in a wiping type of bearing failure. All samples taken through the November 11 to December 9 period indicate excellent engine operating conditions. The sample taken on December 23 gave the first indication of bearing trouble, as shown by the sudden increase in lead content from 2 to 10 ppm. Later samples showed a rapid increase in the lead content, followed by a rise in copper content. This locomotive was removed from service on February 8, when definite bearing trouble was found, which could have caused a scored crankshaft, had the locomotive operated but a few hours or days more.

The effect of dirt in the air inhaled by the engine is indicated by Table 2. The sample taken on December 6 first indicated that a large quantity was being inhaled. In spite of efforts on December 15 to clean the dirt out of the engine by flushing the crankcase and renewing the filters, the dirt and other abrasive particles already created by the scrubbing action of the dirt continued to cause difficulty, which resulted ultimately in considerable damage to piston rings and liners.

The results of the sample taken on April 12 showed that it was necessary to remove the engine from service, since damage had reached the point where a serious breakdown could be expected. On examination, it was found necessary to replace rings, liners, and bearings. The rings were very severely worn, liners scored and worn, and bearings severely scratched.

We thus see quite dramatically how the spectroscope can be used to tell when an engine needs to be overhauled, where to look for trouble, and also when an overhaul is not necessary.

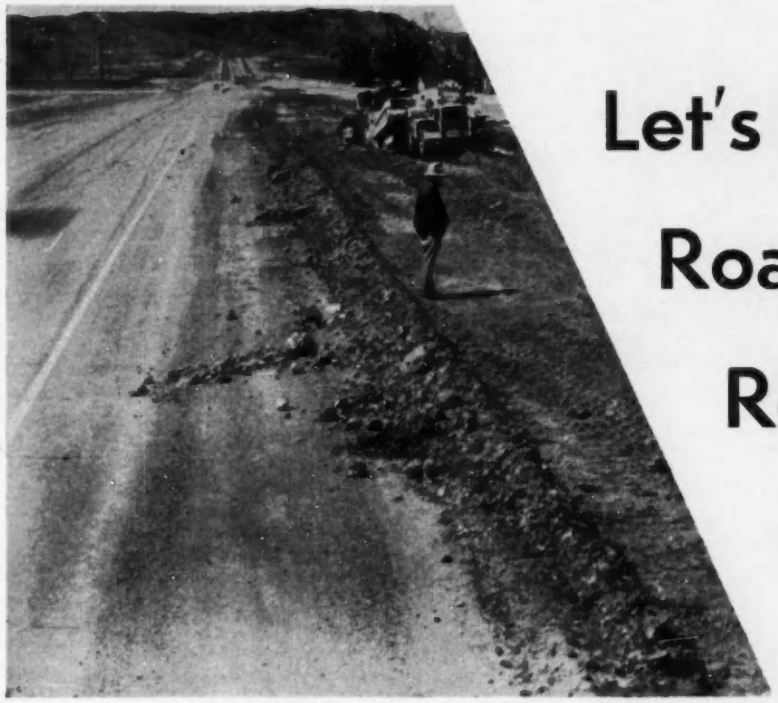
When overhaul periods are based on mileage, needless overhauls are often made—and at considerable expense. If, on the other hand, periodic samples of the crankcase oil are taken and analyzed with the spectroscope, it is easy to tell if the engine is in good condition or if the symptoms of some sort of trouble are evident. Thus, it is possible to take into account the condition of each individual engine rather than the condition implied by experience with the poorest engine.

(Papers on which this abridgment is based are available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ each to members, 50¢ to nonmembers.)

Table 2—Spectrographic Detection of Effect of Dirt in Locomotive Engine (from Sennstrom)

Date of Sample	11/10	11/24	12/6[a]	12/30	1/12	1/25	2/15	3/4	3/22	4/2	4/12
Lead, ppm	5	3	5	6	7	13	8	10	28	14	12
Silicon, ppm	3	6	22	3	4	6	5	9	10	6	8
Iron, ppm	17	19	58	14	18	31	29	50	56	67	95
Chromium, ppm	1	1	9	2	2	4	2	5	6	10	31
Aluminum, ppm	1	1	3	3	2	3	1	4	4	3	5
Copper, ppm	4	2	7	2	2	1	3	2	3	4	3

[a] Engine flushed and filters renewed.



Let's Open Roads to Road-Making Machines!

H. W. Rockwell, Chief Engineer, Allis-Chalmers Manufacturing Co.

Based on paper, "Transportability of Earthmoving Equipment," presented at SAE Central Illinois Earthmoving Industry Conference, Peoria, April 9, 1953.

THROUGH the ages ability to transport people and things from one place to another has been a key factor in the progress of the world. Thus the severe limitations imposed today on earthmoving contractors in movement of equipment from one job to another are strong deterrents to progress.

To comply with restrictive size and weight limitations set up by many state highway departments, it's sometimes necessary to dismantle whole units. Naturally this wastes time and costs money . . . and the taxpayer winds up with the bill. That's because the contractor must then submit a higher bid for the job.

This doesn't mean that contractors should be given unlimited access to transportation facilities without regard to safety and proper rights of others . . . or at the risk of permanent and unwarranted damage to road surfaces. However, it does seem they are justified in asking for relief from certain restrictions which are intended primarily to govern commercial carriers in their everyday use of highway systems.

At the same time, contractors have a right to expect that equipment designers will continue their efforts to improve the transportability of earthmoving machines.

Transportability over highways, then, is of primary concern to both the manufacturer and the user of earthmoving equipment. And both have made sincere and determined efforts to comply with size and weight limitations of the various states.

The Cedarapids twin-jaw primary crusher plant is a good example of designing from the ground up within the confines of highway transportation limitations. (See Fig. 1.) Note that the delivery conveyor at the extreme right of the picture folds, thereby reducing the length of the machine.

Off-the-road, rubber-tired, self-propelled units are the machines that are currently a source of considerable controversy between users, makers, and public road officials.

Here's a good example of what contractors have to go through to make one such unit—an Allis-Chalmers motor scraper—transportable.

First, a bulldozer must dig a trench for positioning the truck-tractor rear wheels in the early stages of the loading operation. The motor scraper is then driven up in proper alignment with the fifth wheel until contact is made on the sloping surface of the belly-guard. (See Fig. 2.) Next, a bulldozer tractor pushes the unit forward and up the inclined fifth wheel until the tractor drive wheels are clear of the ground. The tire and wheel assemblies are then removed and the machine again pushed for-

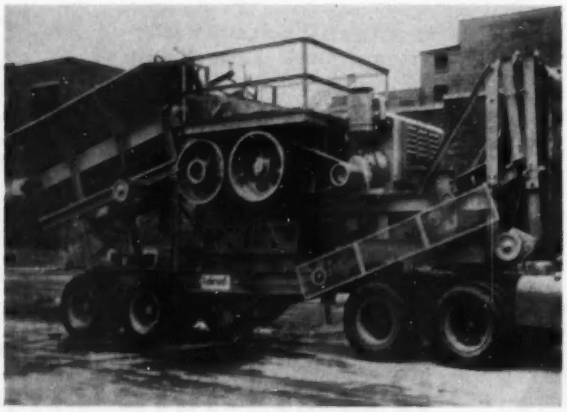


Fig. 1—This crusher plant is a good example of designing a machine from the ground up to meet highway transportation limitations

Fig. 2—This shows part of what contractors now have to go through to make a motor scraper transportable

ward until a specially provided kingpin on the belly-guard engages and is secured by the fifth-wheel latch mechanism.

A rear dolly with leaf springs is then wheeled into place and attached to previously fixed ears on the bottom of the scraper pusher-plate supporting structure. This is done with the cutting edge on the ground so that when the scraper is raised to transporting position, weight is placed on this dolly or auxiliary axle. Normally the scraper axle loading is within highway limits. However, due to the necessity of providing tractor bumper clearance with the truck-tractor cab, the fifth-wheel kingpin is located somewhat ahead of the tractor drive axle. This causes a weight shift to the scraper axle, making it approximately 1500 lb over the limit. Hence the need for the auxiliary axle.

This procedure is representative of the ingenuity displayed by users of earthmoving equipment when confronted with problems of this nature. "Necessity is the mother of invention", is certainly a true statement, as has been proven in many cases of this kind.

Equipment of this kind can, of course, be transported by disconnecting the tractor from the scraper and loading each part on a low-boy. And even though this method is costly and requires use of elaborate handling equipment, it has been used extensively for lack of other satisfactory means.

The normal and logical method obviously would be to let these units transport themselves. Not only would gross vehicle weight be considerably lower, but with better maneuverability, shorter length, and brakes adequate for twice the weight involved, the safety factor would be greatly improved.

What's more, dollars would be saved in the long run. That's because right now contractors—and eventually tax payers—pay an unnecessary penalty for transportation of earthmoving equipment. It is not uncommon to find construction jobs being bid in which the contractor has made provision for truck and rail transportation costs in amounts of $50,000 to $100,000. This sometimes is as high as $2000 or $3000 per mile of constructed highway. True, this cost cannot be eliminated simply by removing the axle load restrictions and fees, but it is a place to start an economy move.

It can be argued: Why lower the bars to such a small segment or minority group of the nation's public road users? That, in itself, in the light of this group's great contribution to highway construction programs weighed against the infinitesimal damage done, would appear to be reason enough for granting relief.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Excerpts from Discussion

H. H. Harrison,
Engineer of Traffic, Illinois Division of Highways

MY remarks will be devoted primarily to the issuance of permits for excess size and weight, with particular reference to the problems of the construction industry.

Naturally, highway engineers must be governed in the issuance of overweight permits by the physical limitations of the road sections in question.

At the same time, we recognize and appreciate the vast improvements which have been made in construction machinery during the past two decades. Most of these improvements provide for greater efficiency and increased production—both of which tend to hold road building costs to a minimum. For this reason, it has been with a sympathetic attitude that we, who are in a sense partners in the game, have looked at the problem contractors face in moving equipment within job limits and between jobs.

To facilitate movement of oversize or overweight equipment within the limits of a construction section, all of our district engineers have been authorized to deal directly with the contractor in the issuance of permits.

As for the author's plea that the earthmoving industry be placed in a privileged class, it is somewhat doubtful that the Illinois legislature would look with favor on such a proposal. It is even more doubtful that other carriers would stand for such legislation.

It seems proper at this point to enter a counter plea that equipment makers improve upon designs to make them conform more closely to size and weight limitations. If such design can be attained, the nuisance of applying for permits can be avoided, thus allowing complete freedom of action.

In conclusion, it is our belief that the Illinois policy on oversize and overweight movement of construction equipment is as liberal as can be developed within the intent of the statutes and as can be defended on a nondiscriminatory basis. With particular reference to overweight, it is as liberal as the structural qualities of our pavements and bridges will permit with safety.

Jack Hartman,
Swords-McDougal-Hartman Construction Co.

SPEAKING from a highway contractor's viewpoint, I do not entirely agree with some of the size and weight restrictions now being imposed. However, I do feel that they are here to stay and that they won't vary much. Therefore, equipment will have to be designed to meet these requirements.

For that matter, Swords-McDougal-Hartman right now purchases only such equipment as can be readily moved over the highway. We may even sacrifice machine performance to get this result. In the case of paving outfits, this means that we buy two small cranes instead of one large one.

Just how much portability can be achieved without sacrificing too much productivity and economy must be determined by the people who design and build earthmoving and construction equipment. So far they've handled this job very well.

Aluminum Finishes . . .

. of greater thickness and density increase suitability of aluminum alloys for wear and corrosion-resistant applications.

Based on paper by **R. V. Vanden Berg** Aluminum Co. of America

ALUMINUM oxide coatings have been developed that have a greater thickness and density than those already known commercially as Alumilite finishes. They are able to support greater loads and to a great extent they overcome the deficiency of the thinner anodic coatings with reference to scratching or indentation type of abrasion. In addition, they are highly resistant to corrosion and have high dielectric strengths.

The type of alloy being coated has a definite effect on the characteristics of these hard coatings. Care must be taken in application to casting alloys because their response is often unsatisfactory, due to their high silicon content. Our present experience indicates that 356 alloy (7% silicon, 0.3% magnesium) responds well. In general, coatings obtained on casting alloys are not as smooth as those on wrought alloys, due to alloy content and inherent differences in microstructure and porosity. Alloys containing high percentages of copper and silicon also will not produce dense coatings of uniform thickness. Coatings will be formed on wrought alloys such as 11S, 14S, 17S and 24S, but they are more critical as to operating conditions, and the coatings produced are not as resistant to abrasion as those on 2S, 3S, 52S, 61S or 75S.

These new coatings have a definite effect on fatigue life. Tests of anodic coatings about 0.0001 in. thick, applied to smooth surfaces, revealed no detrimental effect, but with coatings up to 0.0005 in. thick a slight detrimental effect was noted at higher stresses. The effect is more pronounced on 75S alloy. For high stress applications consideration must be given to design factors to minimize these effects.

Hard anodic coatings have significance for the aircraft industry where a light metal with hard, wear-resistant finish offers a valuable replacement for parts produced from heavier metals of higher inherent hardness. Alloys with hard oxide coatings are now being used, or considered, for gears, pinions, bearing races, gun blast tubes, slides, various pistons, and helicopter blade edges.

In another application our 726 coating is being used to protect 356 alloy cast impellers from erosion. This impeller operates at 40,000 to 60,000 rpm at 600 psi pressure. Unprotected, the surface was actually washed away by the erosive and corrosive action of the liquid moving at such high velocities.

Among other finishes for aluminum may be mentioned hard chrome plating based upon the zinc immersion process; a plating with a new type of nickel-phosphorous alloy which shows promise for wear-resistant applications, particularly for parts having deep recesses; and finally, a vitreous enamel coating which may prove to be the solution to many wear and erosion problems. (Paper, "Aluminum Finishes That Resist Wear and Erosion," was presented at SAE Annual Meeting, Detroit, Jan. 13, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Sun—Sand—Sea Site Suits Summer

Continued from Page 17

technical sessions spilled over into chats on the boardwalk and at the golf course.

If Sir Isaac Newton attended SAE's '53 Summer Meeting, he would have seen automotive engineers give new meaning to his third law of motion (every force has an equal and opposite reaction). He would have heard these engineers tell each other that as soon as they push ahead the boundary of knowledge in one area, nature—and man himself—shoves another barrier under their collective nose.

Fortunately, the engineering task is not truly governed by Sir Isaac's law. Instead of ending in a dead heat in his struggle against the forces of nature, the engineer has been able to forge ahead, however slowly.

At the meeting, automotive men reported their progress against man-produced troubles stemming from the atomic bomb and highway laws; against the numbing paralysis of Arctic cold; against the parasites of preignition and corrosion; and against human fatigue, with automatic transmissions, power steering, and new laboratory facilities.

Peek through Atomic Curtain

In the atomic energy field, the automotive engineer is learning to crawl before walking. For example, he's just starting to determine the damage to motor vehicles from atomic explosions.

Observations made by an SAE committee during an atomic test sponsored by the Federal Civil Defense Administration brought to light some new facts. No one can tell for sure how conclusive the findings are. The test, conducted at Yucca Flats, Nevada, last March, involved a particular atomic device and involved only one given set of test conditions.

The committee drew these conclusions about the test:

1. There was no significant difference between vehicle makes as regards damage sustained.

2. Cars seemed to be generally fire resistant, although fires may start in fabrics.

3. Beyond the major damage radius of the bomb, cars provided good shelter.

The desert terrain on which the 50-odd test cars were arranged may produce entirely different results than those in a large city. A clue to this came from damage to two cars a comparable distance away from the blast—one near a two-story house and the other in the open. The car near the house suffered noticeably more damage.

A more immediate man-made restriction vehicle designers and fleet operators are facing every day is the size and weight limits on commercial vehicles.

Archaic Roads Decried

Said one engineer, these limiting state laws are impeding transportation progress to protect an outmoded, inadequate highway system. Where would aviation be today, he asked, if runway lengths were restricted to 1500 ft, wing loadings to those of 1918, and wheel loads to what a cow pasture could safely support?

Actually, increasing capacity of the average truck would cut down the number of trucks needed to move a given freight volume, and so require less in traffic room.

Truck producers and operators said they aren't asking for freedom to destroy the roads. They ask merely to be permitted vehicles that will insure greatest return to the public; will preserve roads as physical assets, and assure greatest long-run returns on money spent on roads.

Tolerating Arctic Icebox

Engineers have learned to work within the confines of restrictive legislation. But only now are they beginning to learn how to cope with the numbing tenacity of Arctic cold. Transpolar flying is becoming a reality for the military services and the airlines.

Navigation has been one of the chief obstacles to flights across the Arctic. But the new grid navigation system pretty well takes care of that. Still, flying planes over the Arctic requires navigation and meteorological stations, search and rescue bases, and air defense bases. You also have to be able to start and handle both aircraft and auxiliary ground vehicles at these installations.

The Chief and His Lady

SAE President Robert Cass and Mrs. Cass led the activities throughout the week at the forty-second SAE Summer Meeting. They're shown here garbed in native Hungarian dress at the night of the World Tour festivities

Session

Ideally, you would first plan huge heated hangars in which to keep all your equipment. But we are a long way from being able to build and heat such hangars, and to keep them free of roof-breaking snow. So airplanes have to be kept outdoors. Yet fighters have to be flown into the fray fast, and parked bombers moved off the field so they won't be sitting ducks during an air attack.

Currently it takes 4 to 6 hr to start some of our piston engine planes using ground heaters. Warning of transpolar attack—if we get any at all—will give us minutes instead of hours. The goal to shoot for is the ability to start in 30 sec in the Arctic.

Two partial solutions were offered at the meeting: (1) a system that segregates and deaerates fuel-diluted engine oil and (2) a hot-fuel priming system.

The Air Rescue Service reported it's planning for the day when it will add protection of large passenger-carrying planes operating across the Arctic to its global duties. Before that day comes, it hopes to have fully developed two devices that will accurately spot crash locations.

The vise-like squeeze on automotive engineers from parasitic preignition and corrosion is increasing in the case of the former, letting up in the case of the latter.

Preignition is becoming a more common ailment in automotive engines with each passing day. Engine designers and petroleum technologists at the meeting agreed to join forces against the spreading epidemic.

Power's Price

Preignition isn't new. But with engines demanding more of fuels, it's been intensified and spread. That's because tetraethyl lead has become the stepping stone to better fuels. This in turn has brought more deposits to touch off preignition.

So far researchers haven't come up with the cure. But they have found a medication for suppressing it—tricresyl phosphate. By decreasing deposits, this additive disposes of one big cause of preignition.

Recent studies reported at the meeting have shown that:

a. Fuels and lubes, which supply the main ingredients of these deposits, largely determine the severity of preignition in an engine.

b. Any changes in engine operating conditions

which increase combustion chamber temperature or make more oxygen available to support combustion are conducive to preignition.

More impressive are the gains made in recent years against corrosion of parts, assemblies, and vehicles in intraplant, interplant, and overseas shipments.

Manufacturers are treating many parts with corrosion-prevention standbys like slushing compounds and strippable films. For steel and cast iron they are relying heavily on paper impregnated with the new volatile corrosion inhibitors. Impregnated papers won't do for all assemblies, though, because some of the inhibitors attack cadmium plate and other nonferrous materials.

Packaging engineers also warned against green lumber for boxes. It can cause rust.

Engineers also showed where they are making headway in another longstanding crusade. That's the battle for greater comfort, less fatigue of vehicle drivers and passengers. Automatic transmissions and power steering are being expanded in use and improved.

Take self-shift transmissions. Fleet operators at the meeting saw their use on trucks almost a must, particularly in smaller door-to-door delivery trucks. Here are the reasons they gave:

Economics Favorable

With self-shifting jobs, drivers won't be able to misuse the vehicles so much. What's more, automatic transmissions could reduce operating costs. Labor savings possible with easier-to-handle trucks might more than offset slightly higher fuel costs.

A transmission maker said the automatics are naturals for trucks, because "they make a good driver out of any driver . . . and reduce engine and drive line maintenance."

Power steering discussions at the meeting focused on the direction engineering refinements should take. Right now there are two opposing camps. Some favor linkage-type power steering units, others the integral type units.

A threefold argument was made by linkage type adherents: (1) linkage boosters are easier to attach to cars already in the field; (2) noise level in the passenger compartment is lower; and (3) they can be produced in small quantities at lower costs.

The opposition countered that linkage units are more vulnerable to corrosion and to rocks and other objects thrown up from the road. Also they are more susceptible to leakage through packings.

In addition to passenger and driver comfort, automotive engineers are concerned with the well-being of their laboratory personnel. And they've done something about this too, it came out at the meeting.

That's said to be evident by the new look in automotive labs. The new labs feature spacious layouts, generous ventilation, sound-absorbing ceilings, and good lighting. In most of the installations, special care has been taken to provide easy access for locating failures in instruments and fuel lines, and for changing engines.

The new look is paying off too. Utilization is running twice as high on certain new labs as on those they replaced, lab operators proudly reported.

Technical session discussions also brought out the progress being made in Britain and other European countries in high output, low specific weight diesels. Petroleum men told engine designers that fuel systems must be modernized to realize the advantages of improved fuels. At informal round tables men from all avenues of automotive engineering interests exchanged experiences on subjects ranging from ride comfort instrumentation and evaluation to automotive plastics.

(Summaries and highlights of the papers presented at the Meeting are on the following pages.)

The Ladies Found Varied Diversions

Bridge players pause to have their picture taken with Mrs. Dale Roeder (right) who was chairman of ladies' bridge and canasta. Players are (left to right) Mrs. J. H. Bolles, Mrs. H. D. Dawson, Miss Patricia Dawson, and Mrs. G. A. Delaney

Rust Protection

C. O. Durbin, Chrysler Corp., *Corrosion Protection During Processing, Storage, and Shipment—Automotive Application:*

One of the things we've discovered is that when small parts are to be stored in skid boxes, only the top layers need rust protection, usually. Thorough application of slushing compound to the top layers takes care of the whole box. Wood and paper separators used in the box should, of course, be dry and noncorrosive.

Better Packaging

Gordon S. Mustin, Bureau of Aeronautics, *Corrosion Control in Military Packaging:*

Newest of the corrosion-preventing packaging techniques employs a volatile corrosion inhibitor.

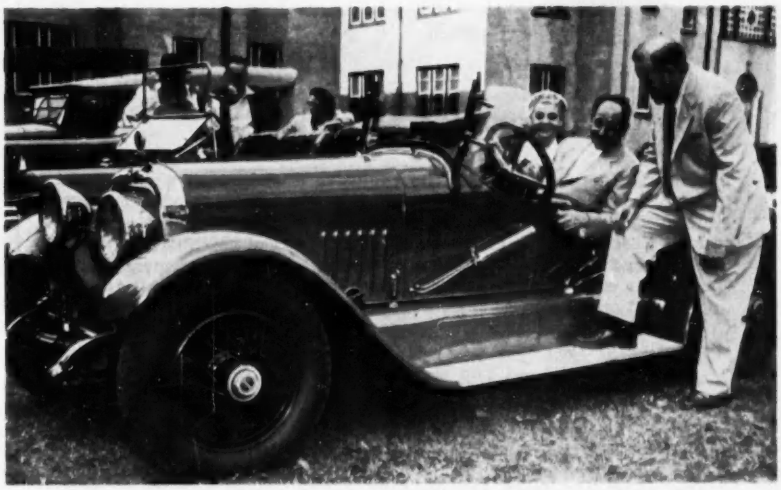
Inside the package goes an inhibitive chemical with sufficient vapor pressure so that it sublimes on the surfaces to be protected. The chemical is such that its molecules are polar. One end wets the metal preferentially, displacing any water already there. The other end is hydrophobic, barring water from penetrating the sublimed film.

Why Restrictions

M. C. Horine, Mack Mfg. Corp., *Does the Public Benefit from Size and Weight Restrictions?:*

Nobody benefits from the raft of nonuniform vehicle size and weight restrictions existing today, especially John Q. Public! That's because this inconsistent flock of do's and don'ts shackle both vehicle designers and fleet operators . . . and this, in turn, boosts the end cost the public has to pay for its transported goods.

A Touch of Yesteryear



Metropolitan Section sponsored a showing of old cars on the first day of the meeting. Shown with one of them, the 1921 Mercer above, are, left to right: Mrs. Lewis Woodland, Lewis Woodland, and S. G. Tilden, Sr., who helped arrange the showing. Merrill C. Horine was chairman of Met Section's reception committee

Tiny Dynamometer

Neil MacCoull (left) shows a small-scale model of The Texas Co.'s chassis dynamometer with a model racer behind the white dial ready to be tested. MacCoull brought the display to the symposium on automotive laboratory design, where California Research Corp.'s chassis dynamometer was discussed. California Research men credited the Texas dynamometer for some of the features they built into their own facility.

New Look in Oil Laboratories

Cooling Water

N. G. Allison, W. L. Kent, and C. C. Moore, Union Oil Co. of California, *An Automotive Research Laboratory in Southern California:*

Cooling water for our engine laboratory is recycled through an evaporative cooling tower. Make-up water is zeolite softened to eliminate calcium and magnesium scale-forming constituents. Sulfuric acid additions control the alkalinity. Chlorine kills off the algae. Chromate, in a concentration of 300 parts per million, inhibits corrosion. Sediment, derived in part from algae and insoluble salts, is removed by filtering a portion of the cooling water stream.

Chassis Dynamometer

B. W. Moore, J. H. Macpherson, and V. C. Davis, California Research Corp., *An All-Weather Chassis Dynamometer:*

In our chassis dynamometer, rear wheels of the test vehicle rest on large steel traction rolls installed on a trun-

Around the Meeting . . .

Atomotive Energeers: That's the exclusive Society into which were inducted members of the SAE committee that cooperated with the Federal Civil Defense Adminstration in the Yucca Flats atomic test. Presented by **H. L. Goodwin**, of FCDA, the certificates of induction read: "(Committee member's name) is a charter member of the Society of Atomotive Energeers by virtue of exposure to the dust and radiation of the Nevada Proving Grounds during the Federal Civil Defense Administration program of the Atomic Test Series of the Spring of 1953."

* * *

Missed at the Summer Meeting by the SAE Iron and Steel Technical Committee and the Engineering Materials Activity Committee was **Vic Crosby**, recuperating in Detroit from a back operation. Both groups wired him from Atlantic City, saying, in part: "What some people will go through to improve their golf game."

* * *

Poetic Injustice: Mack's **Merrill Horine** likened the contradictory vehicle weight restrictions of the 48 states to the following rhyme:

Mother, may I go out and swim?
Yes, my darling daughter;
Hang your clothes on a hickory limb,
But don't go near the water!

* * *

SAE men and ladies crossed paths wth a number of other meetings and conventions in and around the SAE hotels and golf courses. Among them were the Delco-Remy sales organizations; the Circus Saints and Sinners; the Philco dealers and distributors; and the American Bankers Association.

* * *

The account by United Parcel's **Ralph Werner** of his jaunt from New York to California in his "4-cyl" 8-cyl Buick tickled the group at the automatic transmission session. Werner reported that even though he had removed the number 1, 2, 7, and 8 pistons, he was still able to make all but two miles of the trip in high gear!

* * *

In pointing up the difficulty of getting proper college training as a transportation executive, **Howard Willett** of The Willett Co. noted: "I had to major in French in college because that was the only department that would give me the latitude to take the electives I wanted."

* * *

These are several of the brave souls who took a dip into the Atlantic Ocean. But many found the water too cold for surf bathing most of the week.

nion-mounted truck axle. An axle arm transmits reaction torque to a force-measuring system. Stock universal drive shafts deliver power through an eddy-current dynamometer to a second axle belted to a fan. Fan characteristics correspond to typical road load requirements.

Exhaust Disposal

J. B. Duckworth, W. W. Frank, and J. H. Schruben, Standard Oil Co. (Indiana), *New Tools for Research on Fuels and Lubricants:*

Engine exhaust gases to be disposed of enter flexible stainless steel tubing. Water injected into the tubing cools the metal and reduces noise. Stainless pipe carries the gases on to a reinforced-concrete duct outside the building. A blower maintains a slight vacuum in the duct and discharges the gases through a stack above the roof.

Fuel Handling

F. H. Caudel, Shell Oil Co., *A New Look to an Old Laboratory:*

Lines carrying fuel run from a trench circling the lab building, through flexible underfloor conduits, to our test stands.

Each of the four 2000-gal underground fuel tanks has its submerged centrifugal pump. The main breaker switch for each pump motor is wired through pushbuttons in three locations. In an emergency, any switch can stop the motor, and there is no gravity flow.

Centralized Control

M. L. Hamilton, Sinclair Research Laboratories, Inc., *Some Design Features of the Sinclair Engine Laboratory:*

Visitors comment more about the layout of our laboratory than anything else. Principal feature is centralization of control rooms for cells where endurance tests are conducted. This makes it easy for one group of operators to oversee several tests.

High heat-release cells are grouped to simplify ventilation, sound-proofing, and piping.

Engine Stand

O. G. Lewis, T. W. Osbahr, Jr., and S. C. Sperling, Standard Oil Development Co., *A Modern Petroleum Test Engine Laboratory:*

We find that our portable engine stands contribute greatly to mechanic efficiency and comfort. They're specially designed stands that may be rotated about the axis to allow good

access. The worm and gear rotating the mount require only a 10 ft-lb torque to revolve a stripped L-4 engine block. Stand length is adjustable.

New Instrument

J. M. Chandler, Ford Motor Co., *Recent Developments in Engine Instrumentation:*

One of our new tricks is to use radioactive cobalt to study piston ring rotation. We insert a bit of radioactive cobalt wire in the ring and train two Geiger counters on it. Since radiation intensity varies inversely as the square of the distance from the counter, movement of the cobalt can be followed and ring rotations counted.

Atoms 'n Autos

A. L. Haynes, Ford Motor Co., *The Post-War Car and the A-Blast—What Are the Odds?:*

Scientists have a pretty good idea what happens to flesh, bone, and blood when it's exposed to atomic explosion. And now for the first time automotive engineers are finding out how well steel, rubber, paint, and operating mechanisms of motor vehicles resist heat, pressure, and radiation from an A-blast.

Self-Shifting Trucks

W. W. Edwards, GMC Truck & Coach Division, *Advantages and Disadvantages of Hydramatic Transmissions in Truck Operations:*

Just as automatic transmissions are popular items in passenger cars, so they soon will be in light-duty motor trucks. That's because they not only can make a good driver out of any driver, but also because they offer an opportunity to save maintenance dollars.

Drivers' Delight

P. L. Gillan and W. S. Coleman, White Motor Co., *Advantages and Disadvantages of Torque Converter Type Transmissions for Medium and Heavy-Duty Trucks and Tractors in Both Multiple-Stop and Long-Distance Operation:*

Torque converter transmissions probably won't take the medium- and heavy-duty truck fields by storm the way they did with large city transit buses, but don't bet on it. Despite higher initial unit cost and usually greater fuel cost, the ability of torque converters to take the drudgery out of truck driving and to reduce engine and drive line maintenance may make them a real comer!

. . . Around the Meeting

Robert Gardner, a member of the T & M-sponsored panel on "Education, Development, and Future of the Motor Transportation Executive," brought his own sound-recording equipment and recorded the entire two-hour discussion of this interesting panel meeting . . . And it came out very well, Bob says.

★ ★ ★

Reason for the messiness of certain mail recently delivered to Providence, R. I., addresses came out in the meeting of the SAE Filter Test Methods Subcommittee. It seems that a container of the proposed filter test contaminant, which is derived from sludge taken from used crankcase oil, was in the Providence post office on its way to the Fram Corp. Someone dropped the container and the lid popped off, emitting some of the dirtiest dirt anybody ever handled. Since then, packages marked "Handle with Care" and addressed to Fram have received very cautious treatment in the post office, it was reported.

★ ★ ★

Discussion at technical sessions **was reported by:**

W. E. Ellis, Timken Roller Bearing Co.
W. A. McConnell, Ford Motor Co.
K. W. Gordon, Chrysler Corp.
F. K. Seydler, National Carbon Division, Union Carbon and Carbide Corp.
T. B. Rendel, Shell Oil Co.
J. H. Macpherson, Jr., California Research Corp.
R. W. Donahue, Sun Oil Co.
Howard Hill, Shell Oil Co.
J. E. Gillis, Jr., Snow, Ice and Permafrost Research Establishment
Frank Lord, Northwest Airlines, Inc.
Maj. B. A. Goewey, U. S. Marine Corps

★ ★ ★

Chairmen of the technical sessions were:

H. J. Fischbeck, Pratt and Whitney Aircraft
P. H. Pretz, Ford Motor Co.
S. J. Tomkins, Chrysler Corp.
W. E. Thill, Federal-Mogul Corp.
Leonard Raymond, Socony-Vacuum Oil Co.
Lloyd Withrow, Research Laboratories Division, GMC
J. G. Moxey, Jr., Sun Oil Co.
T. B. Rendel, Shell Oil Co.
A. L. Washburn, consultant
H. R. Harris, Northwest Airlines, Inc.
Col. A. C. McKinley, U. S. Air Force
H. L. Goodwin, Federal Civil Defense Administration

★ ★ ★

The morning "Daily SAE", published each day throughout the meeting, was more popular than eggs at breakfast tables. Sponsored by the Timken-Detroit Axle Co., the newspaper chronicled the highlights and sidelights of technical and sports events during the week.

THE DAILY S·A·E

Top-Notch Summer Session in Store
the Second Atlantic City Meeting

THE DAILY S·A·E

All-Time Record Attendance Expected

Golf Champions

Mrs. J. C. Kyle, stroked herself to the women's golf championship

Men's golf champ R. G. Wingerter, made the game look easy

Turbine Test Lab Visited

The U.S. Naval Air Turbine Testing Station at West Trenton opened its gates to SAE members and friends on Wednesday afternoon, June 10, in connection with Summer Meeting.

Capt. W. T. Hines and his staff showed visitors how the Navy has invested some $30,000,000 of taxpayers' money in the facility. Its purpose, the visitors were told, is to provide test equipment that aircraft engine manufacturers must have to check their advanced engines—test equipment so expensive that it would be uneconomic for each engine manufacturer to build his own.

Main feature of the facility is a huge cell for testing turboprops under altitude conditions. Equipment for pressurizing, refrigerating, and exhausting the turboprop cell has been arranged so that it can service any of the facility's two altitude turbojet chambers and two sea-level ramjet chambers when not in full use for the turboprop testing, Capt. Hines explained.

Preignition Gets Diagnosed

Symptoms of Disease

S. D. Heron, Ethyl Corp., *Uncontrolled Combustion in Spark Ignition Engines:*

Destructive or runaway preignition is an Otto-engine disease that occurs at high engine speeds. When infected by the preignition germ carriers—hot plugs, detergent oils, and engine deposits—the patient suffers (1) burns and holes in pistons, (2) cracked cylinder heads, (3) burned, warped, or stretched exhaust valves, (4) damaged spark plugs, and (5) backfires which may cause parts of the ignition system to depart for parts unknown!

Preignition Diagnosis

A. O. Melby, D. R. Diggs, and B. M. Sturgis, E. I. du Pont de Nemours & Co, Inc., *An Investigation of Preignition in Engines:*

Combustion-chamber deposits are the primary germinators of preignition. And any changes in engine operating conditions which increase combustion-chamber temperature or make more oxygen available to support deposit combustion favor the occurrence of preignition. Metal salts, by lowering threshold ignition temperature and accelerating oxidation once it starts, also catalyze this engine disease.

Dr. Cyclops Tells All

D. A. Hirschler, J. D. McCullough, and C. A. Hall, Ethyl Corp., *Deposit-Induced Ignition—Evaluation in a Laboratory Engine:*

Cyclops might well be the name of a new and better laboratory tool for determining the effect of oils, fuels, and additives on deposit-induced ignition. Built around a single ionization gap stuck in the combustion chamber, this electrical stethoscope can both detect and count uncontrolled, deposit-ignited combustion.

Octane Numbers No Cure

R. F. Winch, Sun Oil Co., *The Occurrence of Preignition in Present Day Cars in Normal Service:*

Octane numbers may squelch audible knock and suppress the noise of wild ping, but they aren't very effective in controlling the real troublemaker—preignition. Fortunately, there are these other ways to put the brakes on preignition: (1) increasing preignition resistance of fuels, (2) reducing

Continued on Page 67

AROUND THE WORLD AT ATLANTIC CITY

Admiral Robert "Horatio Hornblower" Steeneck and his consort, Bernice, pause on the boat deck during the Wednesday evening SAE World Tour party. They headed the party committee composed of Mary and Pat Johnson, Thelma and Bill Creson, Alice and Wayne Goodale, Sally and Jack Cole, Dorothea and Bob Hawkins, Ruth and Ray Potter, and Sophia and Ray Snyder. Featured event of the Tour was a costume parade of the nations, in which some 20 couples represented different countries.

Under big hats and little hats guests go up the gangplank to board the S. S. Cass for dancing and the World Tour Varieties featuring Florian Za-Bach.

ROUND Tables Stress Need

More than ever before the menu of round table subjects served up at the meeting satisfied the tastes of engineers at the meeting. Provocative technical questions backed up by competent panel members brought forth vigorous discussion at all sessions.

Most round tables stressed the inter-relationships of the various phases of automotive engineering. Discussion after discussion proved that each specialist depends heavily on other groups of specialists.

Materials engineers implied greater reliance in the future on plastics men. Instrument designers are playing a bigger role in helping build ride comfort into cars. That's because engineers want better measurements of noise, vibration, and ride performance.

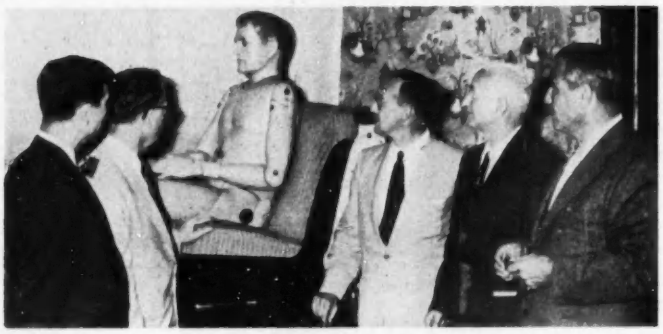
Fleet operators sent out a plea to educators to do a better job in developing motor transportation executives. Engine designers and petroleum technologists look for even closer ties in the future. Preignition and diesel exhaust valve problems are forcing the cooperation.

The need for communication of engineering ideas amongst technical men is greater than ever before, men at the meeting indicated. And SAE round tables are opening new channels for such technical interchange.

Heat-Absorbing Glass

(Left to right) (standing) Secretary W. F. Sherman, AMA; H. C. Doane, Buick; Dr. H. R. Blackwell, University of Michigan; L. W. Parr, Chrysler; (seated) O. Rugg, Ford; W. J. Arner, Libby-Owens-Ford; Leader W. L. Groth, Department of State Police, Virginia; and R. G. Whittemore, Pittsburgh Plate Glass Co. Not included in the picture is V. J. Roper, General Electric, who was also a member of the panel

Auto Seating—Testing and Evaluation by Instrumentation



(Left to right) Secretary V. A. Buck, Chrysler; E. C. Pickard, Ford; Oscar (the dummy); Arthur Bassette, Fisher Body; W. E. Lay, University of Michigan; and Leader J. C. Gordon, Gordon-Chapman Co. Not included in the picture is R. N. Janeway, Chrysler, who was also a member of the panel

Instrumentation and Evaluation of Riding Comfort

(Left to right) (standing) J. J. McDonald, Consolidated Engineering Corp.; A. K. Simons, Bostrom; D. C. Apps, GM Proving Ground; R. O. Williams, Packard; N. E. March, Chrysler; T. E. Stewart, Electro-Mechanical Research, Inc.; L. L. Helterline, Sorensen; G. G. Ross, General Radio Co.; J. D. Rogers, du Pont; W. A. McConnell, Ford; A. D. Pendleton, Brush Electronics; (seated) W. G. Pierce, A. O. Smith Corp.; F. R. Kishline, Nash Motors; Secretary B. E. O'Connor, Houdaille-Hershey Corp.; Leader A. C. Bodeau, Ford; and M. P. Hershey, Firestone

for Engineering Interplay

12-v versus 6-v Electrical System for Passenger Cars

(Left to right) I. C. McKechnie, Chrysler; L. E. Wells, Electric Storage Battery Co.; C. R. Boothby, Electric Auto-Lite Co.; Leader C. W. Rainey, Ford; H. L. Hartzell, Delco-Remy; and Secretary S. M. Terry, American Bosch Corp. Not included in the picture is V. J. Roper, General Electric, who was also a member of the panel

Prospects for Better Passenger Car Brakes

(Left to right) G. T. Ladd, Al-Fin Division of Fairchild; A. J. Burkman, GMC; A. C. Sampietro, Willys-Overland; Leader A. E. Kimberly, Chrysler; Secretary W. R. Rodger, Chrysler; and T. H. Thomas, Bendix. Not included in the picture are the following panel members: N. L. Blume, Ford; D. P. Dyer, Budd; and A. C. Gunsaulus, Goodyear

Tire and Wheel Balance for Longer Tire Life and Easier Steering

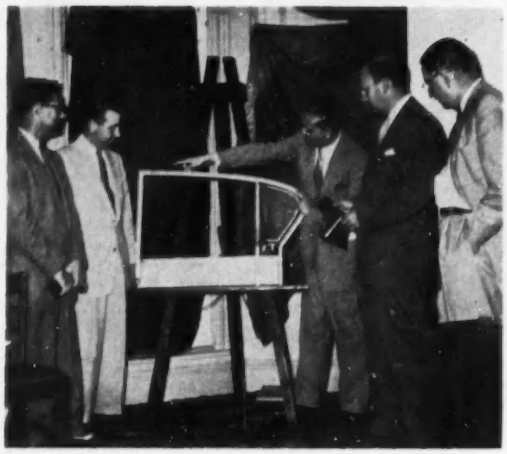
(Left to right) Secretary R. W. Wantin, Ford; A. P. Schweizer, Motor Wheel Corp.; N. M. Webb, Central Greyhound Lines; J. R. Smith, Metropolitan Transit Authority; W. E. Shively, Goodyear Tire & Rubber Co.; and Leader F. B. Lutz, Budd

Education, Development, and Future of the Motor Transportation Executive

(Left to right) Secretary Henry Jennings, "Fleet Owner"; H. L. Willett, Jr., Willett & Co.; H. G. Steigerwalt, Supplee-Wills-Jones Milk Co.; Leader E. P. Gohn, Atlantic Refining Co.; Robert Gardner; J. W. Lord, Atlantic Refining Co.; and T. L. Preble, Tidewater Associated Oil Co.

Please turn Page

Pros and Cons of Door Constructions



(Left to right) Frank Nemeth, Studebaker Corp.; Secretary E. R. Ziegler, Ainsworth Mfg. Corp.; L. H. Nagler, Nash Motors; Leader R. O. Doss, Fisher Body; and H. A. Bolenski, GMC

Cast-In Groove Inserts as a Solution to the Groove Wear Problem

(Left to right) (standing) Ray Sulprizio, United Engine & Machine Co.; R. S. Frank, Caterpillar Tractor Co.; G. T. Ladd, Al-Fin Division of Fairchild; Malcolm Smith, Zollner Machine Works; (seated) Leader A. M. Brenneke, Perfect Circle Corp.; J. M. Smith, Aluminum Co. of America; and Secretary J. W. Pennington, Koppers Co.

Diesel Exhaust Valve Problems Associated with Fuels and Lubricants

(Left to right) (standing) Secretary A. R. Schrader, USN Engineering Experiment Station; L. Raymond, Socony-Vacuum; L. G. Schneider, USN Engineering Experiment Station; Hans Gadebusch, Detroit Diesel; (seated) C. C. Moore, Union Oil Co. of Calif.; Leader H. V. Nutt, USN Engineering Experiment Station; W. Vollentine, Jr., Caterpillar Tractor Co.; W. B. Bassett, Lubrizol Corp.; R. A. Pejeau, Cleveland Diesel; and L. A. Wendt, Shell

Plastics as Automotive Engineering Materials

(Standing) Leader C. F. Nixon, GMC; (left to right) H. D. Thompson, D. G. Products Corp.; A. J. Carter, Chrysler; J. T. O'Reilly, Ford; T. H. Meister, Kaiser-Frazer; Parke Woodworth, du Pont; and Secretary R. E. Van Deventer, Packard

Power Steering Experts Talked About and . . .

Pros and cons of linkage-type power steering were given a thorough airing at one panel session by (left to right): C. W. Lincoln, I. N. Schatzka, Panel Secretary W. A. McConnell, Panel Leader P. H. Pretz, W. K. Creson, C. F. Hammond, T. H. Thomas

Continued from Page 62

engine deposits, and (3) designing engines that are less susceptible to it.

Germ Carriers

J. R. Landis and R. K. Williams, Research Laboratories Division, GMC, *Effects of Fuels and Lubricants on Autoignition in Cars on the Road:*

Whether an engine gets a severe case of autoignition depends on the fuels and lubricants with which it comes in contact. Fuels containing aromatic constituents have greater autoignition tendencies than aromatic-free blends. As for lubricants, harmful autoignition effects hinge on the physical and chemical characteristics of the high boiling—not the more volatile—components of a lubricating oil.

. . . Displayed Their Devices

What-makes-'em-click displays of various linkage-type power steering units proved real attention-getters. On display were units built by Bendix, Gemmer, Monroe, Ross, and Saginaw

Fuel System Design

T. W. Legatski, O. C. Bridgeman, E. W. Aldrich, and R. Rohde, Phillips Petroleum Co., *Fuels and Fuel Systems—a Petroleum Viewpoint:*

If 25% of the cars of a given make and model show excellent fuel system characteristics, why isn't it possible for the other 75% to do so, too?

There appears to be no sound technical reason why future cars should not be equipped with fuel systems of characteristics comparable to the better models now on the road.

Water in Fuel

A. B. Crampton, R. F. Finn, and J. J. Kolfenbach, Standard Oil Development Co., *What Happens to the Dissolved Water in Aviation Fuels?:*

Filter icing from dissolved water precipitating from a warm fuel on cooling may not be the problem as originally envisioned. With good venting, the water should have an opportunity to escape before the fuel temperature is low enough to freeze the water.

Foreign Diesels

P. H. Schweitzer, Pennsylvania State College, and C. G. A. Rosen, Caterpillar Tractor Co., *Whither the European Automotive Diesel?:*

Two-stroke cycle, loop-scavenged, automotive diesel engines got off to a late start abroad, but they bear watching now. Here's why: Loop-scavenged engines seem to be able to deliver the most power in the smallest package. What's more, they're simpler to manufacture and service because there are no camshafts, pushrods, rocker arms, and valves.

British Diesels

C. A. Williams and P. W. Bedale, Shell Laboratories, England, *Some High Output Diesel Engines in Great Britain:*

British diesel-engine manufacturers are after more bounce to the ounce and, except for the really small jobs, they're using pressure-charging—not high speeds—to get it. Why this route to higher specific power outputs? It's getting the nod because positive-displacement blowers are simple in construction, low in cost . . . and available in quantity!

Flying Over the Top of the World

Drawing the Line

Dr. Paul A. Siple, Department of the Army, *Arctic Environment:*

As the Army defines it for military operations, the Subarctic begins where the network of roads, communications, and settlements leaves off. Subarctic and Arctic regions include the whole range of surfaces from deep water to swampy ground and muck; to gravel, cobble, and boulder fields; bare hard rock expanses; and on to strong ice sheets and deep snow fields.

Continued on Page 69

On the Air . . . President Cass . . .

SAE President Robert Cass, in a radio interview by Hazel Hartman, told what SAE has done for the motoring and taxpaying public. He reported that SAE motor vehicle standards have helped cut costs by achieving uniformity of materials and certain parts. In the aeronautic field, SAE standards applied in design and manufacture of military planes have saved the government many millions of dollars.

. . . and Arctic Symposium Participants

Station WFPG listeners heard something about the problems of flying across the Arctic from Col. Bernt Balchen (left), Dr. A. E. Lombard, Jr., James Redding, and Gen. Harold R. Harris. Hazel Hartman interviewed them on her Notebook program. Balchen, who is deputy chief of planning for Arctic operations of the USAF, spoke at the Thursday evening session of the two-day symposium on the operation of airplanes and vehicles in the Arctic.

Lombard was general chairman of the symposium, and Redding assisted him. Lombard is with the USAF Directorate of Research and Development. Redding is with the Research and Development Board of the Department of Defense. Harris was chairman of the session at which Balchen spoke and is president of Northwest Airlines.

Continued from Page 67

The Arctic Pack

Lt. Col. Joseph O. Fletcher, United States Air Force, *The Airplane and the Arctic Pack:*

The development of the airplane is converting the Arctic basin from a hostile wilderness to a friendly backyard.

To the airman, the Arctic pack offers most of the amenities of land and even some not possessed by land.

Over the Top

Einar Pedersen, Scandinavian Airlines System, *Over the Top of the World by Commercial Air:*

Last November Scandinavian Airlines System flew a DC-6B from Los Angeles, to Edmonton, then Thule, and on to Copenhagen. Total flying time was 24 hr, 7 min. Estimated time for projected flights from Scandinavia to Japan is just over 30 hr—or about 15 hr less than the usual route via Rome and Bangkok.

Why Cross the Pole?

Col. Bernt Balchen, Headquarters United States Air Force, *Ground and Air Operations:*

Great Circle courses across Arctic regions are the shortest intercontinental routes between the majority of the world's commercial centers. That makes Arctic air routes of tremendous interest to both the military services and the airlines.

For protection and progress, we must have a network of Arctic weather and radar stations and air bases, operated the year round.

Rescue Service

Brig.-Gen. Thomas J. DuBose, Air Rescue Service, *The Air Rescue Service—A World-Wide Organization:*

The Air Rescue Service serves military and civil aviation of the United States and other countries, aiding airmen from distressed aircraft wherever they may be. ARS operates more than 300 helicopters, amphibians, and land-based transports equipped with droppable lifeboats. Besides intensive Korean operations, ARS averages 175 rescue missions per month elsewhere.

Alaskan Maintenance

Col. Andrew E. Krieger, Jr., Ladd Air Force Base, *Challenges of Alaskan Maintenance:*

Aircraft should be kept outdoors as much as possible, in very cold climates. Otherwise, large changes in ambient temperature cause leaks in hydraulic, fuel, and oil systems and malfunction of instruments because of alternate expansion and contraction. Engines and wings of parked aircraft require tight covers.

Lubricants

Kenneth Boldt, CRC Observer, and H. C. Mougey, Leader of CRC Group on Lubricant Requirements under Arctic Temperatures, *Report of CRC Group on Lubricant Requirements Under Arctic Temperatures:*

Specification 2-104B OE-10 crankcase oil froze so hard at Ladd Field in the winter of 1946-1947 that the men could cut it up for dice.

As a remedy, CRC recommended two fuel-diluted research oils that not only stayed fluid in Alaska but also lubricated a fleet of trucks satisfactorily on a trip down the Alcan Highway and across to Aberdeen. Now oil companies are supplying oils with similar properties but without the fuel diluent under MIL-O-10295.

Safer Oil Dilution

F. E. Carroll, Jr., United Aircraft Products, Inc., *Deaerating Cold Weather Oil System:*

Now available is an aircraft oil-dilution system which not only provides positive segregation of undiluted oil from fuel-diluted oil but also deaerates returned diluted oil.

Also available is a special finned hopper, which reduces warmup time. The system is inherently fail-safe in flight.

Hot Priming

Everett Rowland, Wright Air Development Center Power Plant Laboratory, *Hot Fuel Priming for Cold Weather Starting:*

A hot fuel priming system has been devised to start aircraft piston engines at Arctic temperatures. It heats the fuel so that enough vaporizes to effect a start. To start at -50 to -65 F, fuel must be raised to around 220-240 F. Tank for the hot fuel need hold only 3-5 qt.

Hero Tells Rescue Story

An Air Force man who disobeyed orders and got the Cheney medal for it was introduced by Col. W. S. Dawson, pinch hitter for Brig.-Gen. F. J. DuBose on "The Air Rescue Service—A World-Wide Operation" at the Thursday evening session.

The Air Force man was Maj. Kendrick U. Reeves, of the 58th Air Rescue Squadron. He told how last July he flew his amphibian to the aid of a British commercial Dakota which had ditched in the Mediterranean. He spotted the downed passengers and crew, some in lifeboats and some not, bobbing in waves 8 to 10 ft high.

Regulations forbid landing the amphibian in waves over 4 ft high. Major Reeves knew that if he landed he could not take off, but if he didn't land those 32 men and women in the sea might drown.

He landed, converting the valuable amphibian into a life raft. After several seasick hours, a British vessel arrived and sent over a boat, which struck the amphibian and badly damaged it but succeeded in getting off the survivors.

Major Reeves and his five-man crew eventually made it back to safety via ship. Some went into the hospital. Their amphibian had to be scrapped for salvage. But together, Major Reeves, his crew, and plane had saved the lives of 32 people.

Experts Cite Flock of

Do's

Question: What is the best way to remove scale from small forgings, such as pieces 4 to 5 in. long with 3/16 to ¼ in. diameter sections?

Answer: It takes a small nozzle and at least 90 lb air pressure to remove scale. It's a good idea to put the hot pieces in an edger first to break up the scale.

Question: Under what circumstances should insert dies be used?

Answer: The greater the volume the more need for insert type dies. They can be used on both the blocker and the finisher for smaller parts . . . and on the finisher only for larger parts. They can be used for jet-engine blade dies for either drop hammer or forging press, but are usually not employed to make passenger-car body parts.

Question: What is the value of insert dies?

Answer: Inserts allow better heat-treatment of the die and, thanks to their small volume, use of higher alloy steels that give longer life.

Question: What ways are recommended for cold working the surface of forgings?

Answer: Shotpeening creates a stress depth up to 0.025 in. deep. An air hammer with a ½ in. radius nose may penetrate to 0.035 in. A wedge-shaped roller can be used to cold work fillets.

Question: How about rolling hammer rods to increase strength?

Answer: It has been computed that a stress of 400,000 psi can be obtained by rolling . . . and life increased up to 30%.

Question: What is the best way to ensure getting the same results with different batches of conversion type steels?

Answer: Check with suppliers or other users to find out how each should be handled and heat-treated.

Question: Can the ends of forgings be coin-pressed to avoid machining?

Answer: It is possible to coin-press to 0.005 in. tolerance. While it is also possible to coin-press to 0.002 to 0.003 in., this is not yet commercially practical. Die cost and forging cost go up when such accuracy is required. Therefore, studies must be made to determine if the volume involved warrants such expenditure to offset machining cost.

Question: What steps can be taken to eliminate cracking and seams sometimes caused when conversion steel is put through reduction rolls?

Answer: Watch out for roundness of dies and rolls—they must not be elliptical!

Question: Even with round dies some splitting has occurred when conversion steels are put through reducer rolls. Can this be explained?

Answer: Surface rupture may be caused by high manganese content rather than by the copper contained in the steel.

Question: Is impact forging equipment that forges by opposed hammer blows suitable for making jet-engine blades?

Answer: Completely automatic impact forging equipment is now being tried out. We expect to produce 2400 pieces per hr using 403 stainless steel for the blades.

Question: Can this impact method of forging be used for commercial items?

Answer: Yes, if quantity warrants. This means about 200,000 to 300,000 pieces per month. Actually the impact forging method was developed originally for and by the silver industry to attach handles to knife blades.

Question: How is the forging held?

Answer: There is a tong holder of 1030 steel welded to the stainless steel. It is removed after forging the piece.

Question: How big are these forgings?

Answer: The blades are 2 to 7 in. long and 1¼ to 2 in. wide. The buckets are about 5 in. long and 3 in. wide.

Question: How accurate can forgings be made? For example, can 2½ in. diameter

Forging Do's and Don'ts

L. L. Bower, Waukesha Motor Co.

Report on Panel on Forging held at the SAE Production Forum, Milwaukee, Sept. 8, 1952, under the auspices of the SAE Production Activity. Panel Leader was E. O. Dixon, of Ladish Co.

holes be pierced in 9 in. long gear blank hubs so that broaching can be accomplished without drilling or machining?

Answer: If the outside diameter of the hub is small, then a long pierce will cause distortion. Accuracy is a function of both the hole diameter and the outside diameter of the hub. For example, a 2½ to 3 in. long hub can be held to about 1/32 in.

Question: What is the source of power for the impacter?

Answer: Air at 75 to 100 lb pressure is used.

Question: What is the thought today on de-scaling before forging?

Answer: Scale is taken off mechanically before hammer work. Each forge mill has a hydraulic de-scaler (water pressure of 1500 to 1750 psi) for 4 in. bars and over. Such a de-scaler may cost up to $80,000, but it is good for press work, hammer work, and upsetting. One concern uses two and three serrated-roller de-scalers that require only 5 to 10 sec on work of small diameter. Chain whips are used on larger sizes.

Don'ts

Question: Can dies for jet-engine blades be made by the so-called "hot typing" forge?

Answer: No. Usually they are made on a Keller to 0.005 in., then final finished. Right now, acid etching is being considered as a means for removing the last 0.005 in.

Question: What can be said about maintaining quality in the drop forge shop, that is, how far can dies be worn?

Answer: The answer to this lies in the forging "blue book" where tolerances are listed with the necessary gages to keep within these tolerances. One plant allows 1/16 in. on surfaces that are to be machined, 1/32 in. on surfaces that will not be.

Question: Is 0.45 to 0.50% or lower carbon content preferred for accuracy in forging?

Answer: If sections are thin, high carbon content will cause trouble when cooled.

Forging do's and don'ts were detailed by this panel of experts (left to right) Secretary L. L. Bower, Waukesha Motor Co.; G. F. Daschke, Packard; R. L. Mattson, General Motors; Panel Leader E. O. Dixon, Ladish Co.; C. E. Stone, Interstate Drop Forge; F. G. Millard, Wyman-Gordon; and A. R. Nettenstrom, of American Brake Shoe

A Guide for Those Measuring

CYLINDER pressure diagrams are assuming increasing importance in laboratories devoted to either engine or fuel research.

For these laboratories to be able to realize the most benefit from their combustion-chamber pressure measurements, they must select the technique and the equipment that is most suited to producing the desired result, taking into consideration:

1. The purpose of the test.
2. The precision desired of the test results.
3. The configuration of the combustion chamber and the engine.

Which Technique?

The two techniques available for making the measurements are:

1. Instantaneous pressure recording.
2. Point-by-point pressure recording.

By instantaneous recording is meant the recording of a complete history of engine cylinder pressure (as plotted against crank angle or time) for each revolution of a two-stroke engine or for each two revolutions of a four-stroke engine. This curve is usually displayed continuously on a cathode-ray oscillograph. In contrast, point-by-point recording measures the cylinder pressure at one particular crank angle for each revolution of a two-stroke engine, or each two revolutions of a four-stroke engine. Consequently, it may require thousands of point-by-point measurements to delineate the same curve shape as was recorded by the instantaneous indicator.

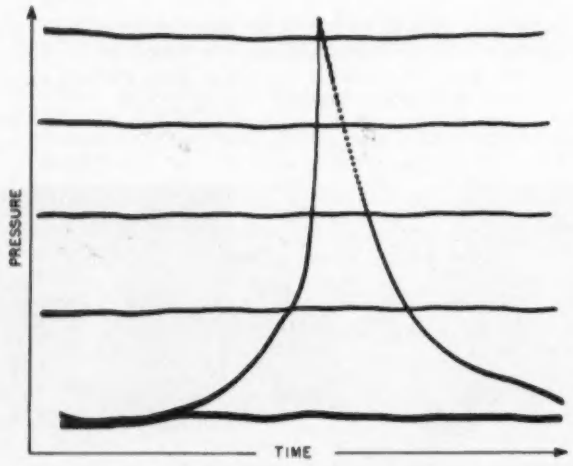


Fig. 1—Instantaneous or continuous indicators require only one explosion to show cylinder pressure as a function of crank angle

In order to make a logical decision as to which of these alternatives to choose, the relative performance of contemporary instruments should be examined.

From a practical viewpoint, the accuracies obtainable when using an instantaneous indicator and a cathode-ray oscillograph are disappointing. If it is permissible to have only one auxiliary hole for pressure measurements in a given combustion-chamber head, then the indicator output must be interpreted in the light of previous calibrations. When using a good instrument having a maximum range of 2000 psi, cumulative errors may easily reach 50 psi. Consequently, when used alone the instantaneous indicator is not well suited to obtaining quantitative data.

On the other hand, pressure differences may be measured to within accuracies of 1%, if some known pressures can be indicated simultaneously with the output of the instantaneous indicator. For example, if two auxiliary holes are available in a given combustion chamber, both an instantaneous and a point-by-point indicator may be used simultaneously. If the point-by-point indicator back pressure is adjusted to known values, in effect a dynamic calibration point is obtained for the instantaneous indicator. The accuracy obtainable is now a function of the accuracy of the point-by-point indicator, which might possibly be of the order of ± 2 psi.

The question that immediately arises is, "If the point-by-point measurements are so much more accurate, why use the instantaneous indicator at all?"

Figs. 1 and 2 illustrate the essential differences between the data obtained from the two systems. Fig. 1 illustrates engine cylinder pressure versus time for one engine cycle, showing rapid pressure variations occurring near peak pressures. This information was recorded in approximately one-tenth of a second.

In contrast, Fig. 2 depicts a pressure versus crank-angle diagram obtained with a balanced-pressure indicator. Depending upon the technique employed, such diagrams require from five minutes to a half-hour and represent hundreds of engine cycles. Consequently, cycle-to-cycle variation causes an appreciable scattering of individual points recorded. Since high-frequency pressure transients are not repetitive, it is obvious that such transients are lost when using the point-by-point technique. Such a loss is intolerable when studying detonation phenomena.

Cylinder Pressure by:

• Instantaneous Pressure Technique

• Point-by-Point Pressure Technique

J. D. McCullough, Ethyl Corp.

Excerpts from paper, "Engine Cylinder Pressure Measurements," presented at SAE Annual Meeting, Detroit, Jan. 15, 1953. This paper will be published in full in the 1953 SAE Transactions.

The essential differences between the instantaneous indicator and the point-by-point indicator then lead to the following conclusions:

A. The instantaneous indicator should be used when rapid accumulation of qualitative data is wanted, or when rapid changes in pressure are to be measured, as in the presence of detonation.

B. When precision is of greatest importance and other factors of secondary interest, the point-by-point system should be used.

Which Particular Instrument?

Once the question of which technique to use has been decided, the user is confronted with the problem of choosing a particular instrument.

To choose the most suitable equipment is not an easy task. This may be illustrated by reference to the many commercial instruments available. Some criteria must, therefore, be devised that will describe the attributes desirable in a cylinder pressure recording instrument. Conversely, the characteristics of each particular instrument should be measurable against these criteria so that relative merits may be assessed.

In order to devise a criterion suitable for evaluation of this type of equipment, some appreciation of the environment in which the equipment must work is necessary. Of course, ideally, a pressure indicator would be affected by pressure alone. As a practical matter, however, complete independence of environment is almost impossible.

Since internal-combustion engines are heat engines, the instrumentation should be unaffected by extremes in temperature. The instrumentation should faithfully measure rapid changes in pressure, and yet be unaffected by engine vibrations caused by explosive combustion. When corrosive combustion products are present, neither the life nor the reliability of the instrument should be affected. In spite of the ignition system voltages and the magnetic fields near an engine, the instrumentation should remain unperturbed. Finally, engines are designed with little thought to providing space or conveniences for research tools; hence, over-all dimensions may be of critical importance.

It might then be said that an ideal indicator should be easy to calibrate, and should faithfully measure pressure throughout the range to be found in the engine regardless of time, temperature, vibrations, corrosive gases and electrical disturbances. Of course, the instrument should leave the engine unaffected by its presence.

Presumably, the most reliable method for making a choice of a particular instrument to use would be to devise engine and bench tests to measure each commercial instrument against the criteria listed above. In most cases, however, such an investigation would require a much greater expenditure of time and energy than would be warranted by the proposed research program. Consequently, the

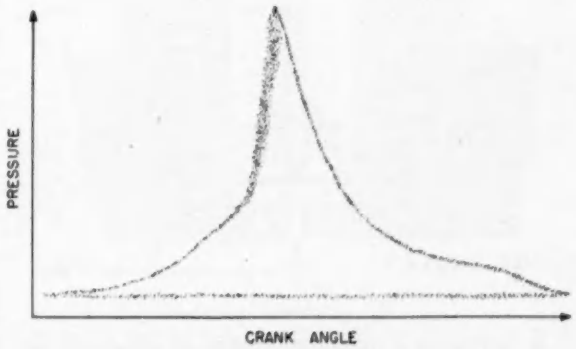


Fig. 2—Point-by-point indicators require as many explosions as there are points to be recorded

Table 1—Relative Performance Characteristics of Instantaneous Indicators

Type	Signal	Static Calibration	Frequency Response	Freedom from Vibration Error	Freedom from Temperature Error	Freedom from Electrical Interference Error	Reliability
Variable resistance (catenary type)	Pressure	Yes	Good	Good	Good	Good	Good
Variable capacitance (carrier type)	Pressure	Yes	Fair	Fair	Poor	Good	Good
Photoelectric	Pressure	Yes	Fair	Poor	Fair	Poor	?
Piezoelectric	Pressure	No	Fair	Poor	Poor	Poor	Fair
Magnetic (carrier)	Pressure	Yes	Poor	Fair	Poor	Fair	?
Magnetic reluctance	DP/DT	No	Fair	Poor	Fair	Good	Good
Magnetostrictive	DP/DT	No	Fair	Poor	Fair	Good	Good

user of such equipment is forced to rely on his common sense and the practical experience of others who have done such evaluation work. Some laboratories have felt the subject to be of sufficient importance to devote the time and effort required.

Continuous Indicators

The following examples will serve to illustrate the kind of testing procedures used to evaluate the performance of various continuously indicating pressure transducers.

Accuracy of calibration was determined by plotting indicator readings against known applied pressures as obtained from a deadweight type of tester. The resulting plot represented the static calibration. Plots obtained from increasing and decreasing pressures showed any hysteresis present. Dynamic calibration by means of rapidly varying pressures was obtained by operating the indicators in an engine under motoring and firing conditions. Errors were determined by comparing the pressures, as read on the indicator, with point-by-point data taken under favorable circumstances.

Freedom from spurious signals due to engine vibration was determined by measuring the indicator output signal when the indicator was subjected to engine vibration, but not to engine cylinder pressures. This was accomplished by first noting the indicator output signal in an engine under conditions of severe detonation. Then, leaving all other conditions the same, the indicator was removed from the engine cylinder head. A solid-bottom adapter was then inserted in the cylinder-head hole, and the indicator screwed into the adapter. Under these conditions, the solid adapter transmitted the cylinder-head vibrations to the indicator but the indicator diaphragm was exposed to atmospheric pressure only. Now, with the engine severely detonating, any indicator output could be regarded as false and due primarily to vibration response. The relative magnitude of the error due to vibration was indicated by comparing the false signals with the signal generated from the cylinder pressure plus vibration.

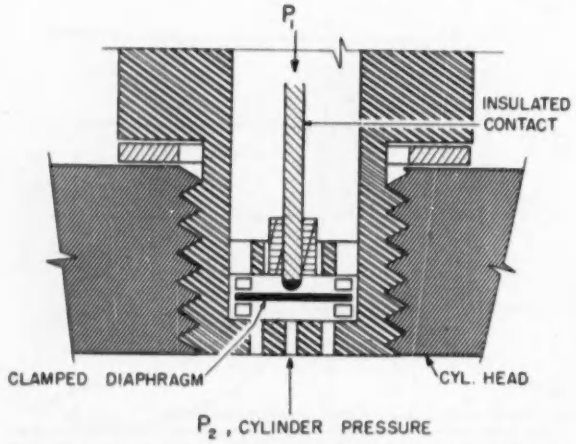


Fig. 3—Construction of typical contact-making balanced-pressure indicator. Motion of center of diaphragm makes or breaks contact with center of electrode, depending upon which pressure is greater

The effect of engine temperatures on the calibration of engine cylinder pressure indicators was studied qualitatively in an engine by noting the shift of the calibration ordinate as the engine warmed up from a cold start. Quantitative measurements of the effect of changes in cylinder-head temperatures were made by mounting various indicators in a dummy cylinder head. The cylinder head was mounted on a hot plate and the temperature noted by means of a spark-plug gasket-type thermo-couple. Those indicators capable of static calibration showed a change in output, even though the diaphragm pressures remained constant.

The effect of electrical accessories on the various indicators was observed by alternately operating and stopping each engine accessory. Relative values of modulation of the pressure curve were thus assigned to each electrical component.

Faithful response to high-frequency pressure transients is largely a function of the mechanical construction of the indicator. With the mechanical damping coefficients usually found in practice, it was reasonable to expect faithful response up to one-fourth the natural period of the mechanical system of the indicator. Since manufacturers' claims as to the natural period of individual indicators were difficult to check, a qualitative measure was obtained by mechanically shocking the indicator in the same direction as the pressure force. The resulting damped oscillation was photorecorded from an oscillograph. Frequencies were measured by comparison with known standards.

A qualitative measure of the *utility* of an indi-

cator may be deduced from its overall dimensions. Other things being equal, a smaller indicator can be used on more engine styles than a larger one.

The results of these engine and bench tests are summarized in Table 1.

Point-by-Point Indicators

It has been inferred that best accuracies can be obtained by means of point-by-point pressure measurements. This is true only if certain conditions are met. An understanding of the essential nature of point-by-point pressure measurements will reveal what these conditional requirements might be.

Point-by-point pressure diagrams are obtained by measuring cylinder pressures in an intermittent fashion. A continuous curve joining these individual measurements then represents the plot of pressure versus crank angle for a given set of engine conditions. The equipment used is ordinarily considered simple to construct and to operate. However, in many cases, undeserved credence is given point-by-point measurements because of the apparent, but unreal, simplicity of the equipment. To illustrate the nature of the difficulties encountered, let us examine these techniques more closely.

One of the first point-by-point techniques involved intermittent operation of an electrically actuated valve connecting the combustion chamber with a pressure gage. If the valve opened for a short time at the same crank angle each engine cycle, a steady pressure gage reading would eventually result. The crank angle and the pressure reading were noted and a new crank angle selected and its pressure reading noted. By this means a curve of pressure versus crank angle could be drawn through the points thus obtained. Later developments produced an instrument for automatically recording this same information.

In spite of the apparent simplicity of this system, the fundamental assumption of pressure balance between the gage and cylinder during the time the valve is open is not justified. Usual durations of valve-open time range from one to two thousandths of a second. This represents a period of 6 deg at 1000 rpm or 18 deg at 3000 rpm. During combustion, rates of pressure rise of 50 psi per crank-angle deg are not uncommon. Thus, during the 6 to 18 deg that the valve is open, the cylinder pressure may change drastically. Consequently, a true balance of pressures cannot occur. It can readily be seen that two cylinder-pressure diagrams could be identical when measured on such an arrangement, yet actually have widely different distribution of pressure dependence upon crank angle. For these and other mechanical reasons, such techniques have been abandoned by most research laboratories in favor of the balanced-pressure method. Fig. 3 depicts the essential elements of a balanced-pressure indicator.

The balanced-pressure indicator utilizes a comparison technique whereby a known pressure, as measured by precision gages, is compared to the pressure in the combustion chamber. A signal is given at the time these two pressures are equal. This action is usually accomplished by the motion of a compliant diaphragm separating the known and unknown pressures. As the diaphragm is

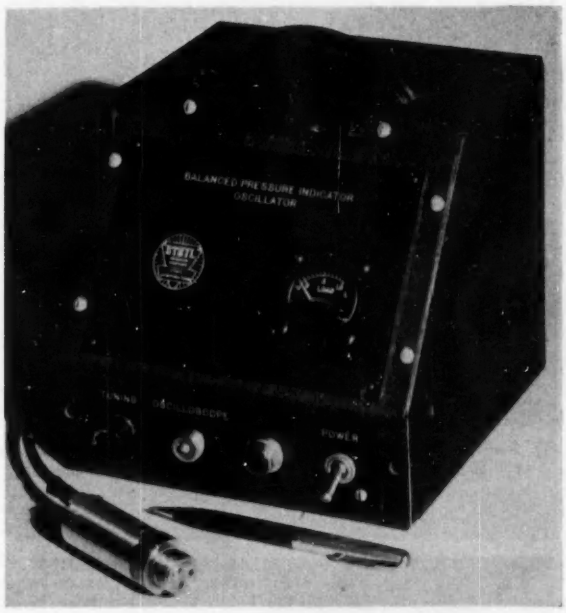


Fig. 4—Experimental balanced-pressure indicator minimizes dynamic errors and is capable of indicating pressure differences greater than 0.06 in. of water

forced against mechanical stops by the greater of the two pressures, it alternately makes and breaks a switch circuit. As the switch circuit is operated, some stroboscopic means is energized to indicate or record the crank angle at which pressure balance occurs. The known pressure is varied and the crank angle for balance read. A plot of pressure versus crank angle then yields the diagram desired.

Careful design and good practice can give results within ± 5 psi. However, unrecognized errors may accumulate, so that most results cannot be justified to better than 15 psi.

From this brief description of the operation of the balanced-pressure indicator, it could be concluded that a good design should exhibit the qualities of (a) low differential pressure necessary to cause an output signal, (b) independence of phe-

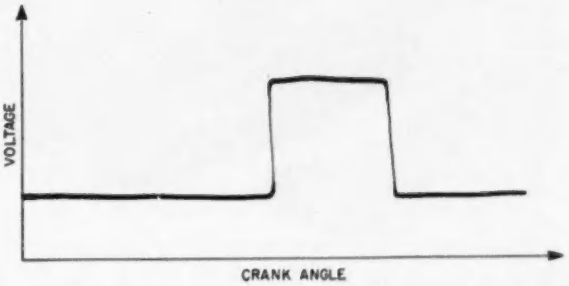


Fig. 5—Oscillogram depicts balanced-pressure-indicator diaphragm motion during one explosion. Total motion of diaphragm is 0.003 in.

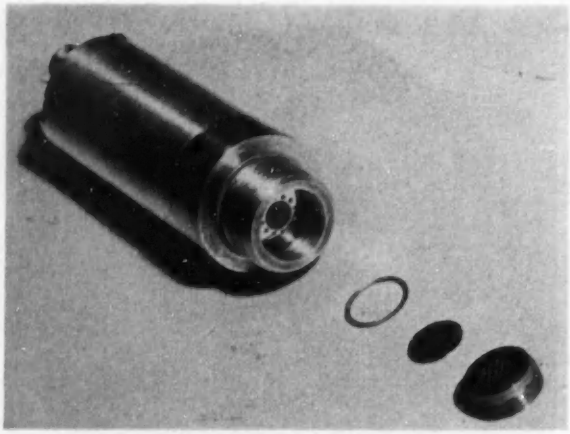


Fig. 6—Exploded view shows simplicity of construction and accessibility of vital parts of variable-capacitance balanced-pressure indicator

Fig. 7—Ignition key shows relative size of variable-capacitance indicator. Maximum diameter is ½ in. Threaded end is 10 mm

Fig. 8—No auxiliary holes are required when using this indicator. It replaces standard 14-mm spark plug, thus providing both ignition and cylinder pressure measurements

nomena other than differential pressure, (c) good corrosion resistance, (d) ease of maintenance, and (e) reliability of operation.

New Developments

Recent developments in indicator equipment may serve to improve the accuracy and convenience of cylinder pressure measurements. The experimental designs to be described show enough promise to be of interest to those using such equipment.

One method of attack on the problem of time delays in balanced-pressure indicators is illustrated in Fig. 4. The purpose of this design is to indicate the first instant of diaphragm motion, and thus to eliminate errors incurred by moving the diaphragm between its limiting stops. This objective is accomplished by using an unclamped diaphragm as one electrode of a variable capacitance in such a way that any motion of the diaphragm changes the capacitance of the system. An electronic circuit produces an output voltage proportional to the displacement of the diaphragm. The output voltage takes the form of a rectangular wave, as shown in Fig. 5. This voltage may be used in any convenient form to actuate stroboscopic devices or to be displayed on an oscillograph.

The most interesting performance characteristics of this indicator are its low differential operating pressure (0.06 in. of water) and its quality of showing the first instant of diaphragm motion in either direction.

The associated electronics consists of a one-tube radio-frequency oscillator, link-coupled to the indicator so that the indicator may be used at a location remote from the oscillator. Since there are no electrical contacts, cleaning may be very infrequent. However, the ease with which cleaning may be accomplished is illustrated in Fig. 6.

One of the difficulties facing the user of pressure-indicating equipment is the problem of providing another hole in the combustion-chamber head to accommodate the pressure transducer. Obtaining enough space to insert the usual indicator often taxes the user's ingenuity. Fig. 7 illustrates a strain-gage indicator of ½-in. maximum diameter, which requires a 10-mm thread in the cylinder head. This indicator has made possible some measurements where other indicators could not be used. Some sacrifice in temperature immunity was accepted in order to keep the external dimensions small.

More convenient than the "pint-size" indicator described above is the combination of a spark plug and indicator described in Fig. 8. This ingenious indicator allows cylinder-pressure measurements to be made without requiring an auxiliary hole in the combustion chamber. A standard 14-mm spark plug thread permits immediate use in most automotive engines. This indicator is also of the strain-gage-catenary-diaphragm family. Some of the design problems may be appreciated when it is realized that, in addition to providing the functions of spark plug and indicator in the same space as a spark plug, it also must shield the low-level strain-gage circuit from the immediately adjacent ignition voltages. That this is accomplished with less error due to temperature and vibration than many com-

mercial indicators attain is truly remarkable. However, it is still short of providing performance equal to the best of the single-purpose transducers. Further development of such an indicator could be extremely helpful to the industry.

Associated Apparatus

Once the factors involved in a particular type of engine research program have been weighed and a suitable choice of pressure-recording method and pressure transducer made, the auxiliary indicating, recording, and calibrating equipment must be assembled. If the user is to obtain quantitative data, it is imperative that the auxiliary equipment be of such quality as to exploit fully the potentialties of the indicator. Fig. 9 shows an integrated system designed to permit rapid recording of engine cylinder pressure diagrams. Since it was designed for use with a strain-gage type of engine indicator, it may also be used for other strain-gage applications in hydraulic, pneumatic, and mechanical force studies. It may be wheeled from room to room and quickly be made a part of the instrumentation for widely different kinds of tests.

At the upper right-hand panel may be seen the strain-gage bridge circuit with its balancing and calibration controls. The second panel from the top houses a variable-frequency audio oscillator for providing time reference marks on the cathode-ray oscillograph. The third panel from the top contains pulse-shaping circuits for introducing reference marks relating engine phenomena to the pressure diagram. Such reference marks might include known crank angles, the start of injection, ignition timing, and the like. This panel also contains an electronic switch, which permits time-sharing of one cathode-ray tube trace so as to provide effectively three channels of information to be recorded. This same panel also contains an oscillator circuit such as was described in the paragraph on balanced-pressure indicators. The lower panel houses an electronically regulated power supply providing direct current for the bridge circuit. The lower left-hand panel is a balanced, wide-band, direct-current amplifier to multiply the bridge output voltage to a level suitable to operate the double-beam oscillograph mounted in the upper left-hand side of this portable console.

Groups of five plugs at each panel provide a patch-cord arrangement for flexible inter-connection of the various components. Not shown are integral cooling fans and line-voltage stabilizers. More than 6000 individual pressure-time records have been obtained on such an instrument.

A companion device for the measurement of the known pressures used with the variable-capacitance balanced-pressure indicator is shown in Fig. 10. Three sides of this cabinet house three precision pressure gages accurate to one part per thousand. A nitrogen tank supplies the source pressure, while an integral vacuum pump extends the operating range below atmospheric pressure. These instruments may be used together to present visual displays of engine cylinder pressures versus time. In order to make a permanent record of the data thus displayed, some sort of recording equipment is required.

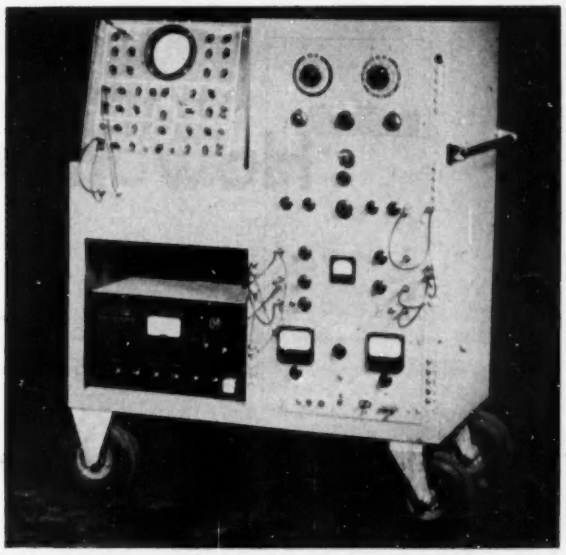


Fig. 9—Rack and panel design, together with patch-cord connections permit flexible usage of components housed in this console. Use of double-beam cathode-ray oscillograph permits simultaneous recording of cylinder pressure, known crank angles, ignition timing, known frequencies, and known pressure calibration points

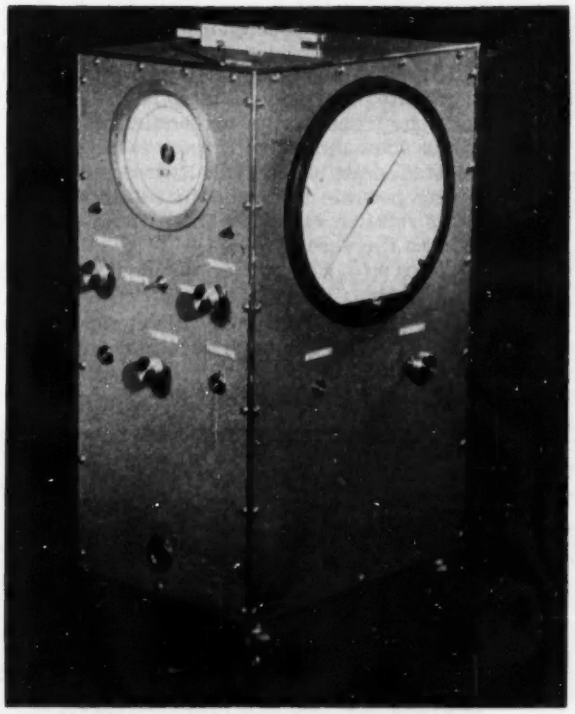


Fig. 10—Cylinder pressures are read from these precision gages, which measure known pressures applied to balanced-pressure indicator

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

How to Put the Hex on

What About Salt on Roads?

THE danger of accelerating corrosion of automobile bodies by using salt for deicing roads is not real enough to warrant discontinuing these accident-reducing treatments.

However, this doesn't mean that salt solutions are no more corrosive than plain water. Fact of the matter is that both dilute and concentrated brine solutions are more corrosive than distilled water. (See Fig. A.)

Strangely enough, the reason why salt aggravates corrosion is that it interferes with the formation of protective rust films which show up in plain water. Clinging to the surface as it does, this hygroscopic substance permits corrosion to continue at a lower relative humidity than would otherwise be the case.

There are two rather obvious ways to combat this. They are:

1. Wash cars frequently to get rid of the salt before it can exert its corrosive influence.

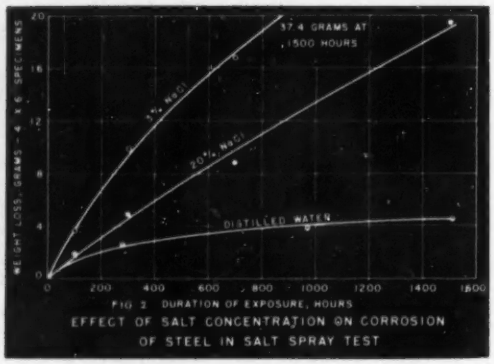


FIG 2 EFFECT OF SALT CONCENTRATION ON CORROSION OF STEEL IN SALT SPRAY TEST

Fig. A—Both dilute and concentrated brine solutions are more corrosive than distilled water

2. Keep cars in a dry place so that even if hygroscopic salt films are not removed by washing, relative humidity will not be high enough to allow corrosion to continue.

Still a third approach is to use such corrosion inhibitors as polyphosphates and chromates in the salt laid on roads. While effectiveness of these inhibitors varies with concentration of the salt solutions formed (dilute solutions are difficult to inhibit), good results from their use are reported.

Table A pretty well summarizes the extent to which salt treatment of roads may accelerate corrosion . . . and the value of using a corrosion inhibitor in the salt. Note that:

1. Specimens attached to cars where they would be subjected to splash effects were corroded from 2 to 4 times as much as those exposed simply to the atmosphere in the same localities.

2. Salt treatment accelerated corrosion a little. However, where an inhibitor was used (City A), corrosion was actually less than where no salt was used (City C).

Table A—Rates of Corrosion of Steel Under Different Conditions of Exposure

Test Location	Tons Salt Used on Roads per 100,000 Population	Location of Test Specimens	Observed Rate of Corrosion In. Per Year
City A	3500[a]	Fastened to Car	0.0040
City B	500	"	0.0062
City C	None	"	0.0046
City A	3500[a]	On building roof	0.0022
City B	500	"	0.0015
City C	None	"	0.0027

[a] 1 to 2% polyphosphate inhibitor added to salt

Corrosion of Car Bodies

F. L. LaQue, International Nickel Co., Inc.

Based on paper, "Corrosion of Automobile Bodies," presented at SAE National Passenger-Car, Body, and Materials Meeting, Detroit, March 3, 1953.

WHAT are the facts of life about corrosion of automobile bodies? What atmospheric and operating conditions are conducive to it? What kind of steels suffer most from it? What can passenger-car makers and designers do about it? The answers to all of these questions can be wrapped up in a neat package by considering:

- The corrosive medium.
- The metal that is corroded.
- Ways to prevent corrosion.

The Corrosive Medium

The nature and amount of corrosive pollutants in the air, plus the materials thrown up from the road, largely determine the severity of the corrosive action on an automobile body. However, attack is also influenced considerably by atmospheric humidity, amount of rainfall, and the presence in the air of particles of dust, ashes, and soot.

The spread in corrosivity toward iron and steel of atmospheres in different localities is amazing. (See Table 1.) Note that it can be as much as 500 to 1! It is not surprising, therefore, that there is a great variation in the incidence and extent of corrosion of automobiles in different parts of the country. It is reasonable, also, to expect that most trouble from corrosion will occur in seashore environments and in heavily industrialized communities.

The principal corrosive constituents of atmospheres are the products of combustion of various fuels in industrial areas and salt particles blown in from the ocean in coastal regions. To these may be added nitric acid generated by synthesis from nitrogen and oxygen by the action of atmospheric electrical discharges—lightning.

The potential corrosivity of dilute acids resulting from the solution of products of combustion in condensed moisture was indicated by tests on iron specimens exposed to water used to scrub sulfur gases, and so forth from the smoke from a power plant boiler. The pH of this water was between 3 and 4—not much under that of acid rainwater—and the temperature was 130 F. In this very dilute

Table 1—Relative Corrosivity of Atmospheres at Different Locations Toward Open-Hearth Iron Specimens

Location	Type of Atmosphere	Rate of Corrosion In. Per Year	Relative Corrosivity
Khartoum, Egypt	Dry Inland	0.00007	1
Abisko, North Sweden	Unpolluted	0.0002	3
Singapore, Malaya	Tropical Marine	0.0006	9
Daytona Beach, Fla.	Rural	0.0007	11
State College, Pa.	Rural	0.0017	25
South Bend, Ind.	Semi-Rural	0.0019	29
Miraflores, Canal Zone	Tropical Marine	0.0020	31
Kure Beach, N. C.			
800 ft from ocean	Marine	0.0026	38
Sandy Hook, N. J.	Marine, Semi-Industrial	0.0033	50
Kearny, N. J.	Industrial Marine	0.0035	52
Vandergrift, Pa.	Industrial	0.0037	56
Frodingham, England	Industrial	0.0067	100
Daytona Beach, Fla.	Marine	0.0093	138
Kure Beach, N. C.			
80 ft from ocean	Marine	0.032	475

acid solution, iron was corroded at the very high rate of 0.8 in. per year.

Somewhat surprisingly, heavy rainfall and high humidity do not necessarily cause accelerated corrosion of steel. As a matter of fact, frequent and heavy rainfalls that wash off corrosive chemicals and corrosion-stimulating dust particles are likely to reduce rather than accelerate corrosion.

The Metal That Is Corroded

The steels used for automobile bodies are not selected with resistance to corrosion as a major consideration. In fact, emphasis on low cost and fabrication qualities tends to favor compositions of steel that may approach a minimum rather than a maximum resistance to atmospheric corrosion. Such a low level of corrosion resistance would result from (1) restrictions on alloying elements that would improve corrosion resistance and (2) the occasional presence of a relatively high sulfur content without a compensating amount of residual copper.

A number of years ago an analysis was made of a large collection of automobile body parts which had suffered especially severe corrosion in service. It was found that 90% of these parts had a copper content under 0.05% and, in the worst cases, the low copper content was associated with a relatively high sulfur content.

It would appear that corrosion difficulties are likely to be more severe if the steel used has a high ratio of sulfur to copper. It seems desirable to keep this ratio under 0.5—either by restricting sulfur or, probably more conveniently, by insuring the presence of sufficient copper (around 0.10%) to compensate for high sulfur.

Ways to Prevent Corrosion

Resistance to corrosion can be raised to even higher levels by the addition of appropriate amounts of such alloying elements as phosphorus, chromium, and nickel. Depending on the corrosion resistance of whatever composition of carbon steel is used for comparison and the severity of the atmospheric environment, improvement in resistance to atmospheric corrosion that can be achieved by alloying steel may be as great as 10 to 1. (A superiority of 5 to 1 is common.)

The advantage of extra resistance to atmospheric corrosion is not confined to the performance of bare steels. It also extends to steels carrying the protective coatings ordinarily applied to automobile bodies. A considerable improvement in corrosion resistance of steels for automobile bodies and performance of paint coatings on them can be achieved by employing steels of appropriate alloy content and by giving the steels a phosphate pretreatment before painting. Naturally best results will be secured by doing both.

Outside of the heavy-reinforced asphaltic coatings applied to automobile underbodies for sound deadening and corrosion prevention, protective coatings normally applied to underbodies, frames, or interiors of body panels have been definitely inferior to those applied to exterior surfaces. For example, where four coats might be used on the outer surfaces, a single priming coat would be all that would be applied to the inner surfaces. While outer surfaces are subjected to some deteriorating influences more severe than those encountered by inner surfaces, the reverse is also true—particularly with respect to effects of road splash, accumulation of water in recesses, and restrained drying.

It is not surprising, therefore, that most corrosion of automobile bodies proceeds from the inner surfaces. It follows, also that there is considerable room for improvement in the protective schemes applied to these inner surfaces. It is unlikely that any new or novel coatings will be required. It may suffice simply to recognize the need for more protection, such as might be achieved by using conventional coatings of adequate thickness.

From a design standpoint, the best way to combat corrosion is to insure that water cannot collect in pools and that all surfaces not only drain readily, but are able to dry quickly.

The corrosive water that must be taken care of by adequate drainage may come from such sources as:

1. Rain entering around windows.
2. Moisture in warm air drawn into confined spaces during the day. This will condense out as the air cools at night.
3. Water thrown up into recesses from wet roads.

Elimination of collected water can be achieved readily by providing outlet holes where they are needed and, if necessary, by pitching the surfaces so that water will drain to these ports. There should be no excuse for water collection where it could be drained readily, such as inside door panels, in spare-tire recesses, or similar depressions in trunk spaces.

Provision for drainage, then, should not be too difficult. But it may not be easy to design and build automobile bodies so that the steel surfaces will dry quickly. And quick drying is important. Rust films that have a chance to dry can become relatively impervious to moisture and thus exert a protective effect on the underlying steel.

This is especially important if it is desired to take advantage of the extra resistance to atmospheric corrosion that can be secured by using alloy steels. These steels may show only a slight superiority over carbon steel if they remain wet most of the time.

The underbodies of cars have limited opportunity for natural fast drying. Consequently, it would seem to be in order to give special attention to the possibility of speeding up drying of critical surfaces by some means of controlled, forced ventilation.

The author previously proposed that air heated by the engine might be channeled or deflected to those surfaces of the chassis or underbody that might otherwise experience very little natural drying action. Thus, the time that these surfaces would be subjected to corrosion would be reduced and an opportunity for developing protective rusts would be provided. This suggestion is repeated here because it might well prove to be the most effective new step that can be taken to reduce corrosion of automobile underbodies and facilitate protection by means of simple coating systems.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Automatic Power Controls for Helicopter Engines

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and
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Excerpts from paper, "Helicopter Power Requirements Necessitate Tight Limits on Engine Power Controls," presented at SAE Annual Meeting, Detroit, Jan. 14, 1953.

THE peculiar mission that helicopters perform, such as flying close to Korean ridges, along pipelines, and close to city buildings—always very close to the ground—are such that the pilot's attention is necessarily focused on the position of the ship. The pilot cannot, practically, be expected to devote very much attention to engine or rotor instruments. Therefore, some virtually automatic means for maintaining constant rotor rpm during maneuvers is necessary. This can be done by coordination of throttle position with rotor blade pitch. Coordination between throttle setting and collective pitch setting means that the rotor power required at various pitch settings must always be matched by an equal engine output.

The methods of obtaining throttle-pitch coordination can be divided into four classes:

1. Manual operation of pitch and of throttle.
2. Mechanical linkage between collective pitch and throttle.
3. Mechanical linkage plus servo.
4. Pure servo.

The first class—manual operation of pitch and throttle—relies upon the pilot to match pitch setting and engine power. This method is unsatisfactory for two reasons. First, appreciable effort would be required by the pilot to maintain constant rpm, and pilot fatigue would be a problem even on short flights. Second, even though the pilot may be trained to coordinate throttle and pitch for ordinary maneuvers, he cannot be expected to match throttle and pitch properly in an emergency, when good coordination is most necessary.

The second method of coordination—a mechanical linkage between the collective pitch and the throttle—has proved very popular. Good coordination can be obtained by this method, and the linkages are relatively simple. The simplest mechanical system consists of a linear connection. However, the relationship between collective pitch and throttle is not a linear function, and, therefore, a linear-response system cannot be expected to give good coordination.

If a cam is designed such that the schedule follows the curve shown in Fig. 1, which is the cross-plot of collective pitch and throttle position, good coordination will result. The cam is inserted into the linkage between the carburetor arm and collective pitch lever.

Although the throttle must be coordinated with

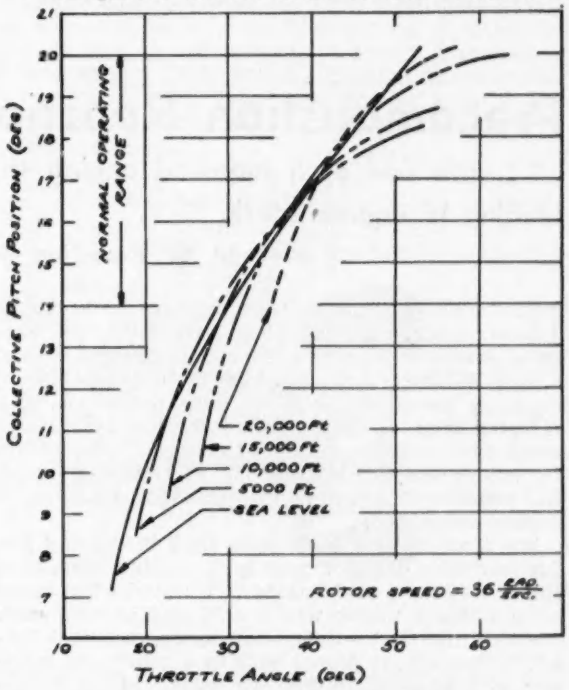

Fig. 1—Throttle angle versus collective pitch angle

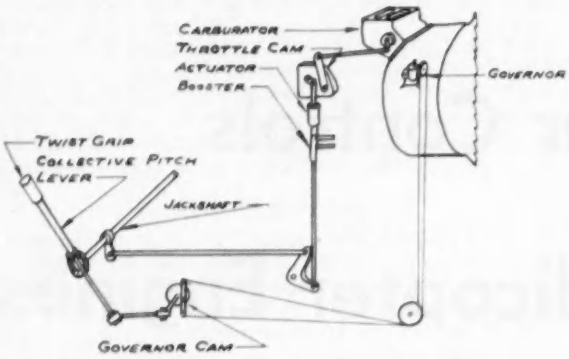

Fig. 2—Schematic diagram of throttle linkage

the collective pitch movement, it is also necessary for it to operate independently because it must be possible to start and warm up the engine, take-off rpm must be set, and it must be possible to reduce the engine to idle for practice autorotation landings, independent of collective position.

Most helicopter companies accomplish this by making the throttle setting sensitive to collective position as well as to a twist motion or a hand squeeze motion. One example of such linkage is shown in Fig. 2. The throttle jackshaft is mounted at the center of rotation of the collective stick. A pinion gear is mounted at the end of the collective pitch stick and meshes with a gear on the throttle jackshaft. Then collective stick movement rotates the jackshaft. Also, a twist motion rotates the throttle jackshaft. This describes a workable mechanical system.

The method of coordination just described will be accurate to the extent that the data for the assumed conditions of (a) sea-level operation, (b) constant forward velocity, and (c) constant rpm are accurate. For constant r/c the rotor horsepower required does not change appreciably with altitude because the extra induced power required is offset by a reduction in power required to overcome form drag. However, at 15,000 ft the power available from a turbine engine has reduced 27% and from a reciprocating engine, 37%; hence, some throttle adjustment must be made as the helicopter climbs to altitude. If it is necessary to operate at several rpm's additional throttle adjustments will be necessary.

The pure servo system is an autopilot and can be justified weight-wise and cost-wise only when the mission is long or accurate pinpoint hovering is necessary. I do not know of a fully developed helicopter autopilot.

Summarizing: the high rate of speed change of the rotor leads us to demand a system that adjusts throttle setting for changes in collective pitch. The attention of the pilot is necessarily focused outside the cockpit, and therefore coordination must be done for him. This can effectively be done with a mechanical linkage incorporating a cam. A refinement in the form of a trim device may be added, when the additional weight and cost are justified by the helicopter mission and operating flight plan.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Precombustion Reaction Studies . . .

. . . with use of a motored engine throw further light on chemical phenomena leading to engine knock.

From paper by **M. W. Corzilius, D. R. Diggs and D. L. Pastell** E. I. du Pont de Nemours & Co.

THE tendency of a fuel-air mixture to knock is determined by the extent and type of precombustion reactions occurring in the unburned charge ahead of the flame front. For convenience in studying these reactions we have made use of a motored engine. Since this technique substitutes compression of the unburned charge by the piston for compression of the end gas by the flame front, the problem of isolating the proknock reactions is greatly simplified.

We find by this technique that increasing the fuel/air ratio of the charge to an engine suppresses the initiation of cool flames and narrows the range of conditions under which cool flames can exist. We also find that autoignition tendencies of different hydrocarbons do not vary in a consistent manner with changes in fuel/air ratio. Many hydrocarbons show a characteristic minimum in the conditions required for autoignition; this minimum usually occurs close to the stoichiometric fuel/air ratio. The autoignition tendencies of other hydrocarbons which do not exhibit the minimum point are usually suppressed by increases in fuel/air ratio.

The physical conditions required for the initiation of cool flames in *n*-heptane are dependent solely on the absolute concentration of the fuel. These conditions are essentially independent of the engine time factor, but the conditions required for autoignition become more severe as the time factor is decreased.

Tests show that tetraethyl lead exhibits the greatest antiknock effectiveness in *n*-heptane at high motored engine speeds. In isooctane, tetraethyl lead shows the same effectiveness at all engine speeds.

We have reached the conclusion that the sen-

sitivity of a fuel, as determined in ASTM knock-test engines, may be interpreted in terms of motored engine autoignition limits. Although *n*-heptane is assigned by definition a temperature sensitivity of zero, it may, under some conditions, react to its physical environment in such a manner that its temperature sensitivity exceeds that of benzene. (Paper, "Some Factors Affecting Precombustion Reactions in Engines," was presented at SAE Fuels and Lubricants Meeting, Tulsa, Nov. 6, 1952. It will be printed in full in 1953 SAE Transactions. It is also available in full from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Electric Wheel Drive . . .

. . . featured on Tournatow represents basic propulsion principle applicable to stationary equipment as well as to construction machinery.

Based on paper by **D. K. Heiple** R. G. LeTourneau, Inc.

THE Tournatow, designed especially for towing large aircraft, has a short wheelbase and an extremely low silhouette, both of which are made possible, or at least simpler to produce, through use of the electric wheel principle.

The basic power plant is a GMC 6-71 diesel engine with two direct-coupled generators. One generator, producing direct current with a variable output of from zero to approximately 300 v by means of a special potentiometer control, furnishes power to each of the four d-c wheel motors. Full reverse is obtained by changing the field polarity of this generator. The second generator produces 120-cycle, three-phase, alternating current and about 300 v with the engine at governed rpm. This generator supplies the power for steering, auxiliary winching, battery charging, and auxiliary lighting. It also furnishes direct current for supplementary field excitation of both generators through a rectifier. Initial excitation comes from the batteries at 24-v direct current. These batteries also power the electric starting motor for the diesel engine. The a-c generator would also furnish the power for bulldozer, scraper, crane, or any other allied equipment which might be used.

The wheel (Fig. 1) is a complete power package, including gear reduction, direct current traction motor, and braking devices (both dynamic regenerative and spring loaded multiple disc). Ball socket hangers support the wheel load while the motors drive through a floating pinion. Both wheel and motor swing together during steering operations thus eliminating any need for transmitting power through universal joints.

Because direct current wheel motors require a variable balance of armature and field strength to obtain the variable speeds and torques required, the electrical control system is designed to provide this ratio automatically for any position of the variable potentiometer and varying conditions of motor load. Control is accomplished by swinging the potentiometer handle from neutral forward to full ahead, and back to full reverse. Front and rear wheels steer independently of one another through separate finger tip switches controlling two steering motors, or together through a common switch which ties them together. The steering control makes possible moving obliquely in tight quarters or on road at top speed as easily in one direction as the others. Differentiating power to the wheels during turns can be incorporated in the design, but has been found to be relatively unimportant in field applications.

The Tournatow drive as a motor wheel principle has also found its way into relatively stationary applications such as a rotary digger head, the powered pulley of a six foot conveyor belt, and roll drivers for a plate mill. It is simply a matter of propelling the material involved rather than moving a piece of prime equipment. These uses point to the possibility that the Tournatow is not only an interesting addition to the construction machinery equipment group, but is the application of a basic propulsion principle which has a role in a multitude of uses. (Paper, "Electric Drives for Earthmoving and Construction Machinery," was presented at SAE Central Illinois Section Earthmoving Industry Conference, Peoria, April 8, 1953. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

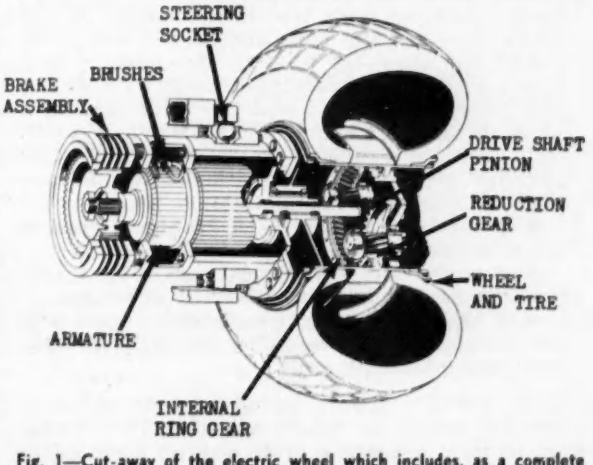

Fig. 1—Cut-away of the electric wheel which includes, as a complete power package, gear reduction, direct current traction motor and braking devices

Would Passengers Be Safer

WOULD rearward-facing seats give airline passengers a better chance to come out of survivable accidents alive? This is one of the $64 questions facing the airline industry today.

Right now airline operators are neither for nor agin' rearward-facing seats. However, they're not satisfied with the supposition that rearward-facing seats *per se* are safer than forward-facing ones. And before they make such a radical change in seating arrangement, they want proof that turning the seats around will improve safety.

The U. S. Navy, U. S. Air Force, Royal Air Force and some foreign airlines are installing rearward-facing seats in some of their transports. But U. S. airline operators feel, with much justification, that their safety problems are different from those of troop transports. That's because comfort and appearance are important . . . and civilian passengers can be very choosy about whether they sit facing forward or aft.

Airline operators, then, want to make their decision on whether to turn seats around on the basis of facts—not hearsay and personal opinions.

Rearward-Facing Seats Better IF . . .

Right now, Cornell's Crash Industry Research is trying to ferret out the "facts." With the meager information now available, it appears that ultimate judgment will support current assumptions about the safety of rearward-facing seats only:

- IF the mean force of typical survivable transport crashes is materially greater than 10 g.
- IF the direction in which crash forces act is such as to utilize the assumed safety features of rearward-facing seats, that is, if the crash forces throw the head and body against the seat-back.
- IF the seats are properly designed so that failure of the seat structures themselves does not produce an injury . . . and the structures as a whole do not store energy and act like a catapult.

By the same token, rearward-facing seats probably will not provide marked safety advantages over forward-facing seats:

- IF the force of survivable transport crashes is not severe.
- IF severe forces in typical survivable transport crashes act in many different directions.
- IF the design of rearward-facing seats does not include many of the safety features now built into forward-facing seats.

Wide use of rearward-facing seats in airliners, therefore, hinges on which way the "IFS" swing. This, in turn, depends a great deal on what information crash research digs out of accidents. A number of all-important questions need to be answered.

For example, no one yet knows the magnitude of either jolt loads or the mean force of survivable accidents in large transports. Perhaps "crash force" does not exceed 10 g. Perhaps it is much more. But there are indications that it it less than 10 g. Until factual data are available, however, we will have to abide by conclusions drawn from accident-injury studies. And these indicate that failure of 6-g and 9-g seats and safety belts is due to torsion and jolt loads rather than to "crash force" in the sense of mean fore and aft accelerations. Brief jolt loads may be in the order of 15 to 20 g, whereas the mean force of a crash acting on cabin sections which remain intact may be 10 g, 5 g, or even less.

If this low force concept proves to be true, it is possible that good forward-facing seats will take care of passengers in all but a small percentage of highly destructive airline crashes.

Unanswered, too, is the question of what would happen to passengers if they were thrown against strong, resilient rearward-facing seat structures in a 20- or 30-g deceleration. Would their heads be catapulted toward, and smashed against, the rigid seat-backs in front of them? Also what would happen if passengers' heads, necks, and backs were part way out of rearward-facing seats in tumbling, cartwheeling, bouncing crashes? Would they get very serious—perhaps fatal—injuries, even in low force crashes?

Airline operators are asking this triple-threat, prize question: "If rearward-facing seats are safer than forward-facing ones, how much safer are they . . . and in what percentage, of what type, of survivable accidents?"

To find reliable answers to these and many other difficult questions, Cornell's Crash Injury Research group is undertaking a cooperative accident-injury study of airline accidents with investigators of the Civil Aeronautics Board. From this study—and from military and other accidents in which rearward-facing seats are used—information should be obtained which will make possible decisions based on facts.

No Proof Yet Aft-Facing Seats Are Best

We have not analyzed many airline accidents to date, but those we have studied do not suggest that rearward-facing seats would have materially increased passenger protection. Perhaps our sample of recent accidents, in the parlance of statisticians, is "unique." Perhaps it is valid. Possibly this year we will get radical departures from current evidence, or we may get measurements of forces which will throw needed light on this and related safety problems.

One thing we do deplore is ready public accept-

in Rearward-Facing Seats?

. . . This is a $64 question that airline operators would like to have answered. But so far crash researchers can't tell them.

Hugh De Haven, Crash Injury Research, Cornell University Medical College

Based on paper, "Protective Design in Forward- and Rearward-Facing Seats in Transport Aircraft," presented at SAE Annual Meeting, Detroit, Jan. 15, 1953.

ance of newspaper reports based on poorly drawn conclusions. For example, reporting that all passengers survived an accident simply because they were seated in rearward-facing seats does not make sense in crashes where crew members seated in forward-facing seats also were uninjured.

For the present, the Cornell Committee for Transportation Safety Research goes along with military groups in believing that safety advantages promised by strong, aft-facing seats should be fully explored.

We realize that protective design in rearward-facing seats is not yet fully developed . . . and should go much further than merely beefing up seats and turning them around. Designers should bear in mind that people get thrown around in severe, cartwheeling accidents. And if held only by safety belts, they can be hurt by striking non-yielding, seat-back structures ahead of them—whether they are sitting in forward-facing or rearward-facing seats. It seems almost certain, therefore, that accident studies will show that military personnel should be equipped with a combination safety belt and shoulder harness to take full advantage of the protective values of rearward-facing seats.

In conclusion, when and if facts prove that rearward-facing seats are safer than forward-facing ones, airlines in this country will no doubt adopt them.

(Paper on which this abridgment is based is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members, 50¢ to nonmembers.)

Based on Discussion

Question: Does a seat structure need to be stronger in a forward- or rearward-facing seat?

Answer: Forward-facing seats in some types of planes are not designed to withstand heavy safety belt loads. The load from the safety belts can be arranged to bypass seats and can be carried to basic structures by cables or wires. By comparison, to support head, torso, and arms under 20-g loads, the backrests and framework of rearward-facing seats will have to be very much stronger.

Question: What type of injury is most likely to result from side loads on seats?

Answer: The strength of the armrests would largely govern this. If the armrests are too strong, injury of the lower ribs—with possible internal injuries—might be expected.

Question: Is there a chance that passengers might "torpedo" in reclining rearward-facing seats?

Answer: Pure fore and aft accelerations without heavy, vertically acting components are rare. Therefore, I do not think people would torpedo out of reclining rearward-facing seats.

Question: How about reports that belts cause serious injuries?

Answer: When 1000-lb seat belts were first studied, some old-timers thought they would cause serious injuries. Experience has shown, however, that safety belt installations which give a snubbing force of 2000 lb can be broken by 100-lb people without serious injury. We are studying crashes in which 3000-lb safety belts are used and have no reports of injuries yet. The Navy finds that 5000-lb safety belts rarely cause injury.

Question: Do you believe that scenic value of rearward-facing seats will eventually win them favor over forward-facing ones?

Answer: Yes, I believe that rearward-facing seats will come . . . and the better view they afford will be one important reason why. With seats turned around, passengers sitting amidship in a low-wing plane will get a chance to view clouds and countryside . . . which they couldn't do if they were facing forward.

About

Willard Rockwell

Walter Rockwell

COL. WILLARD F. ROCKWELL, chairman of the board of the Timken-Detroit Axle Co. and of Standard Steel Spring Co., has announced the consolidation of the two companies. The new company, which will operate 21 plants in eight states, will be known as Rockwell Spring and Axle Co. Colonel Rockwell will be chairman of the board.

WALTER F. ROCKWELL, for many years president of Timken-Detroit Axle, will retire after 33 years with the company to devote himself to private business interests. He continues as a member of the SAE Finance Committee.

WILLIAM H. GRAVES, vice-president of engineering of Packard Motor Car Co., Detroit, was recently awarded honorary membership in Tau Beta Pi, national engineering honorary society, at the University of Michigan, from which Graves graduated in 1919. Graves joined Packard a month after his graduation. He was SAE vice-president for Passenger Car Activity in 1947.

M. B. TERRY has been appointed president of American Brakeblok Division of American Brake Shoe Co., Detroit. He was previously executive vice-president of American Brakeblok, and has been with the company since 1943.

HOWARD G. VESPER, president of California Research Corp., has been elected vice-president of Standard Oil Co. of California. Vesper has been with the corporation since 1922, and has been president of the research subsidiary since 1946.

JAMES J. BLACK has been named vice-president of engineering of Trailmobile, Inc., a subsidiary of Pullman, Inc., in Cincinnati, Ohio. Before 1950, when Trailmobile was purchased by Pullman, Black was vice-president of the Trailmobile Co., and prior to that served as chief engineer.

D. BASTOW, chief engineer of Jowett Cars, Ltd., Yorkshire, England, was recently awarded the Starley Premium of the Institution of Mechanical Engineers for his paper on independent rear suspension.

ROBERT C. JONES, who was previously senior technologist for the Shell Oil Co. in New York City, has transferred to Shell Development Co., Emeryville, Calif., as research engineer.

WILLIAM A. FURST is now project engineer, research and development, for ACF-Brill Motors Co., Philadelphia, Pa. Furst was formerly chief mechanical engineer for O. C. Szekely and Associates in Philadelphia.

EDGAR ROSE has been named director of research for Kiekhaefer Aeromarine Motors, Inc., Fond du Lac, Wis. Rose was previously research engineer at Massachusetts Institute of Technology, Cambridge, Mass.

JAMES M. CRAWFORD, president of SAE in 1945, has been elected vice-president of the San Diego Business Men's Art Institute. Retired some time ago as a vice-president of General Motors and living at La Jolla, Calif., Crawford has resumed the activity as an artist which first engaged his interest as a youth before becoming an engineer. He has recently been on television with his paintings, "showing what a retired man can do with his paintings."

Members

JEROME OTTMAR has been elected vice-president of Metals and Controls Corp., Attleboro, Mass. He was previously manager of engineering and sales for the company's general plate division. He has been with the company since 1938.

FRED C. PATTON, who recently retired from Pacific Electric Railway Co., has bought an alfalfa ranch in the San Joaquin Valley near Turlock, Calif. The new place is only 25 miles from Atwater, where **EARL COOPER** now lives, Patton reports. He and Mrs. Patton moved there on July 1.

N. P. PETERSEN, president of Canadian Acme Screw & Gear, Ltd., recently attended the Rotary International Convention in Paris, France, as president-elect of the Rotary Club of Toronto. Petersen is SAE vice-president for Production Activity.

NIELS C. BECK, dean of Parks College of Aeronautical Technology, was re-elected executive secretary of the Aviation Writers Association at the Association's annual meeting in Fort Worth, Texas.

CLAIRE H. FELLOWS, director of the engineering laboratory and research department of the Detroit Edison Co., has been elected vice-president of the American Society for Testing Materials for a two-year term. At the same time **THEODORE E. OLT,** director of the research laboratories of Armco Steel Corp., was elected to ASTM's board of directors for a three-year term.

KENNETH G. FOSNES has joined Boeing Airplane Co. at Renton, Wash., as a tool engineer. Fosnes was formerly project engineer for the Kenlee Corp., Seattle, Wash.

DONALD K. STROHSCHEIN is now a designer for the Trackson Co., Milwaukee, Wis. He was previously designer for Caterpillar Tractor Co.

ROBERT V. MATHERS has joined Harry Ferguson, Inc., Detroit, as layout draftsman. He was previously junior engineer for J. I. Case Co., Rock Island, Ill.

RANDOLPH J. ROSHIRT has been elected vice-president of Aluminum Industries, Inc., Cincinnati, Ohio, and will be responsible for integrating the production and sales activities of the company, as well as having charge of new product development. He was previously executive vice-president of Bohn Aluminum and Brass Corp., Detroit.

C. S. FERGUSON has been appointed director of engineering of Marshall-Eclipse Division of Bendix Aviation Corp., Troy, N. Y. He was previously technical director in charge of the division's chemical products development.

THOMAS WOLFE, president of Pacific Airmotive Corp., Burbank, Calif., has also been named chairman of Pacific Airmotive's board of directors, in addition to his present assignment. Wolfe is vice-chairman for Aircraft Activity of SAE's Southern California Section.

LOUIS C. LUNDSTROM has been named assistant director of the Proving Ground Section of General Motors Corp., Milford, Mich. Lundstrom joined the section in 1939 after receiving his bachelor's and master's degrees in engineering from the University of Nebraska. Since 1947, he has been head of the mechanical engineering department at the Proving Ground.

Honorary Degree to Colwell

Photograph taken by Mrs. Henry Perry

SAE PAST-PRESIDENT A. T. COLWELL (center) was awarded an honorary degree of Doctor of Engineering by Case Institute of Technology on June 4. Colwell is vice-president of Thompson Products, Inc.

In conferring the degree, Case President T. Keith Glennon cited Colwell as a "distinguished engineer of the automotive and aircraft world, author, engineering executive, and leader in technical industries and professional societies, who has brought honor to his city and his profession."

Attending the ceremonies at which Colwell received his degree were **SAE President ROBERT CASS** (left) and **FREDERICK C. CRAWFORD**, chairman of the board of Thompson Products, Inc. (right).

DONALD G. STONG has been promoted to assistant regional sales manager, southeastern region, for Cummins Engine Co., with headquarters in Atlanta, Ga. He was formerly sales engineer for Cummins.

JOHN J. PALERMO, project engineer for the mechanical development division of National Biscuit Co., New York City, is now also chief engineer of the Christopher Co. of New York City.

SCOTT M. KENNEDY has been appointed director of sales of the Permite automotive service division of Aluminum Industries, Inc., Cincinnati. Prior to joining Aluminum Industries, Kennedy was general sales manager of the Chanslor & Lyon Co., San Francisco.

JOHN J. TREUTELAAR is now an engineer for the Heil Co., Milwaukee. He was chief production engineer in the Sterling Division, White Motor Co., Milwaukee.

FRANK E. PHILLIPS, formerly vice-president in charge of sales, for Gemmer Mfg. Co., Detroit, has been promoted to senior vice-president of the company.

GERALD REINSMITH has been named manager of the Washington, D. C., office of Narmco, Inc. He was formerly with the Army as chief of the non-metallic structural materials unit of the Office of the Chief of Ordnance.

JOHN G. McNAB, assistant director in the research division of the Esso Laboratories of Standard Oil Development Co., presented a paper on "Field Studies on Gasolines and Motor Oils under Severe Service Conditions" at the midyear meeting of the American Petroleum Institute in New York City.

GEORGE L. SMITH has joined General Electric Co., Evendale, Ohio, as an engineering designer on gas turbine components. Smith was formerly assistant research engineer for Fairbanks, Morse and Co., Beloit, Wis.

WILLIAM C. CLAS has been named chief inspector of Magnus Metal Division of the National Lead Co., Albany, N. Y. Clas was previously standards engineer for American Locomotive Co., Schenectady, N. Y.

FRED A. STENNING, who was previously automotive product designer for Ford Motor Co., has joined Northrop Aircraft, Inc., Anaheim, Calif., as engineering design checker.

JOHN M. EVANS, formerly vice-president of the Griffin Chemical Co., San Francisco, is now a partner in the Evanstrom Co. in San Francisco. Evans is a past chairman of Northern California Section.

DONALD L. BOWER is now sales manager of Tekwood, Inc., a subsidiary of United States Plywood Co. in Lakeport, N. H. Bower recently completed a 21-month tour of duty as an Air Force colonel at the Air Technical Intelligence Center at Wright-Patterson Base, Dayton, Ohio. Before being recalled to the Air Force, Bower was Washington representative for United States Plywood.

JOHN C. WORTHINGTON is now fuel and lubricant engineer for Standard Oil Co. of California in Portland, Ore. Worthington has recently been serving with the U.S. Army, and before that was with the Pacific Electric Railway in Los Angeles.

ROY H. DAVIES, formerly a tractor design engineer for Ford Motor Co., Ltd., Dagenham, Essex, England, is now serving as lieutenant in the Corps of Royal Electrical Mechanical Engineers. He is second-in-command of a Light Aid Detachment attached to the 4th Queen's Own Hussars.

JOHN PERRY has joined the Lamb Electric Co., Kent, Ohio. Perry was formerly consulting engineer in Turin, Italy, for the Mead Carney International Corp. of New York City and London, and prior to that was with Dominion Electrohome Industries, Kitchener, Ont.

ROBERT J. SCHROEDER is now with Pioneer-Central Division of Bendix Aviation Corp., Davenport, Iowa, as a design checker. He was previously at the John Deere Dubuque Tractor Works of Deere Mfg. Co., Dubuque, Iowa.

DAVID W. PORTER has been transferred from General Motors Proving Ground, Milford, Mich., to the engineering laboratory of GMC's Cadillac Motor Car Division, Detroit, where he is a junior engineer.

GEORGE R. McMULLEN has been named Kansas City district manager for the Gustin-Bacon Mfg. Co. He was formerly manager of transportation sales for Owens-Corning Fiberglas Corp., Toledo, Ohio.

L. W. HAMILTON is now regional parts and service manager for Chrysler Corp. of Canada, Ltd., Vancouver, B. C. Hamilton was previously service promotion manager for Alberta and British Columbia.

EDRED B. WILLIAMS has joined GMC's Truck and Coach Division, Pontiac, Mich., as senior layout man. He was formerly project engineer for Stewart-Warner Corp. in Indianapolis, Ind.

RUSSELL N. BOOTH is now design engineer for Minneapolis-Honeywell Regulator Co., Minneapolis, Minn. He was previously field engineer for the J. I. Case Co., Racine, Wis.

ALAN H. BLAIR has been released from the U.S. Air Force and is now military relations engineer for Lockheed Aircraft Corp., Burbank, Calif.

R. S. BRIGHT has been named general manager of Chrysler Corp.'s Indianapolis, Ind., plant. He was previously general manager of Chrysler's Michoud ordnance plant, New Orleans, La.

H. T. DANIELS has rejoined Climax Engine and Pump Mfg. Co., Clinton, Iowa, as factory field engineer for Climax, but more recently has been an independent service engineer in Oklahoma City, Okla.

F. V. IRWIN is now district service representative for Chrysler Corp. of Canada, Ltd., with headquarters in Red Deer, Alberta. Irwin was formerly service manager for Marquis Motors, Ltd., Lethbridge, Alberta.

ERNEST R. JOHNSON has been appointed assistant vice-president in charge of operations of Republic Steel Corp., Cleveland, Ohio. Since last September, he has been district manager of Republic's central alloy district, and before that served as assistant manager and chief metallurgist for the district. He has been with Republic and one of its predecessors, Central Steel Co., since 1922.

WILLIAM A. BLUME has been appointed vice-president in charge of sales of Gemmer Mfg. Co., Detroit. He was previously president of the Asbestos Mfg. Co., Huntington, Ind., and vice-president of the Thermoid Co., Trenton, N. J. Earlier, he was president of American Brake Block Co.

STUART P. HALL has formed a new industrial publicity and public relations agency, Hall Industrial Publicity, Inc. with offices at 425 Maccabbes Building, Detroit 2, Mich. Hall, a mechanical engineering graduate of Rensselaer Polytechnic Institute, began his career in Detroit as a student engineer for General Motors' Research Laboratories Division. Subsequently, he was a member of Buick's engineering staff, an editor of "Product Engineering" at McGraw-Hill Co., and later editor-in-chief and general manager of "Design News" in Detroit. Most recently, he has been vice-president and director of public relations for Denham & Co., Detroit industrial advertising agency.

WILMOT SANDHAM, former automotive engineer for General Petroleum Corp., has been named regional manager for Cummins Engine Co., Inc., for the Southwest region. Sandham is vice-chairman for Fuels & Lubricants Activity of SAE Southern California Section. He has presented many technical papers before SAE Sections on the West Coast.

WILBUR G. PERRIGUEY has been appointed manager of the sales engineering division of Esso Standard Oil Co., New York City. With Esso since 1944, Perriguey has been assistant manager of sales engineering since 1950. He is vice-chairman of the Fuels and Lubricants Activity of SAE's Metropolitan Section.

NORMAN A. DUFFANY has been named manager of the Chicago office of Precision Rubber Products Corp., Dayton, Ohio, succeeding **HARLAN H. DAVIS**, who has entered the publishing field as a media representative. Duffany joins Precision Rubber Products after 19 years with the New York Air Brake Co., Watertown, N. Y.

HENRY B. REICH has joined United Tool and Die Corp., Detroit, as sales engineer. Reich was formerly senior buyer of tools, dies, fixtures, jigs, gage and cutting tools for Ford Motor Co., Dearborn, Mich.

JOSEPH H. JONES has been named assistant district manager of the central alloy district of Republic Steel Corp. in Canton and Massillon, Ohio. Jones had been superintendent of Republic's Massillon steel plant for the past seven years. He joined the company in 1935 as a metallurgical field service engineer.

HENRY H. DURR has been named engine development engineer for Reo Motors, Inc., Lansing, Mich. He was previously industrial and marine engine application engineer, and has worked on special project-engine design assignments. Before joining Reo a year and a half ago, he was with GMC's Inland Division. As a lieutenant in the Navy, he took part in the Bikini atom bomb tests.

JOHN T. NADOLNY has joined Waukesha Motor Co., Waukesha, Wis., as experimental engineer. He was previously experimental test engineer for Hall-Scott Motor Division of ACF-Brill Motor Co., Berkeley, Calif.

DONALD P. FRANKEL has been named assistant director of customer relations for Marquardt Aircraft Co., Van Nuys, Calif. He was previously special assistant to the director of engineering and manufacturing.

R. M. GARRETT, who was previously staff manager of friction materials for Johns-Manville Sales Corp. in Cleveland, has been transferred to the company's offices in New York City.

ROBERT S. SCHUYLER, who was previously regional truck manager for Dodge Brothers Corp. in Chicago, has been transferred to California as truck sales supervisor for Dodge. He will live in San Mateo, Calif.

JETHRO BENJAMIN, who was previously superintendent of maintenance for Rowley Transport Co., Baltimore, Md., is now with the Eastern Contracting Co. in Baltimore.

JULIUS R. KOPPELMAN has joined the Sandia Corp., Albuquerque, N. M., as design draftsman. He was previously draftsman for Alpha Engineering and Machine Works, Chicago.

W. B. BURNETT has been appointed technical director of United Carbon Co., Inc., Charleston, W. Va. Dr. Burnett was formerly director of the Foundation for Industrial Research at the University of Wichita.

ALEXANDER HOSSACK has been promoted to chief project engineer with the ordnance division of American Locomotive Co., Schenectady, N. Y. He was previously project engineer.

R. J. OSTRANDER has been named assistant to **DAN M. GUY**, director of technical service at Ethyl Corp.'s research laboratories, Detroit. **H. A. TOULMIN** succeeds Ostrander as supervisor of motor vehicle operations. **GERALD STANKE**, formerly project engineer, has been named to the newly-created post of assistant research supervisor for motor vehicle operations.

C. W. GENSON, formerly gear engineer for the Aircraft Gear Division of the Dana Corp. in Toledo, Ohio, has been promoted to chief gear engineer at the Division's headquarters in Fort Wayne, Ind.

CHARLES J. JACOBUS has joined the Clark Equipment Co., Buchanan, Mich. Jacobus was previously junior engineer for the Frank G. Hough Co., Libertyville, Ill.

ROBERT J. TAYLOR has been released from the Air Force, with which he was serving as a first lieutenant, and has joined the tire testing division of the B. F. Goodrich Co., Akron, Ohio.

K. C. HELLER is now with the engineering department of Mayhew Machine and Supply Co., Dallas, Texas. He was previously with the industrial division of Funk Aircraft Co., South Coffeyville, Kans.

FRANKLIN C. LINDSAY, formerly flight inspector for Consolidated Vultee in Fort Worth, Texas, is now flight inspector for Grand Central Aircraft Co., Tucson, Ariz.

HERBERT L. DICKEY retired July 1 after nearly 30 years with Socony-Vacuum Oil Co. He has been Socony-Vacuum resident consulting engineer to automotive manufacturers, with headquarters in Detroit, since 1932. Dickey, who has been an SAE member since 1913, plans to return to his native state, California, and to live in Oakland.

JAMES J. MARKS has joined GMC's AC Spark Plug Division, Milwaukee, Wisc., as project engineer. Marks was formerly a test engineer for Nordberg Mfg. Co. in Milwaukee.

WILLIAM L. COOK is now with International Harvester Co. in Emeryville, Calif., as project engineer. He was previously assistant to the chief engineer of Brown Mfg. and Equipment Co., Charlotte, N. C.

WOODROW W. HALSTEAD is now vice-president of the Dick Wheeler Co., Detroit. Halstead was formerly sales engineer for the B. F. Goodrich Co. in Detroit.

WALTER E. BENULIS is now senior aerodynamicist for Republic Aviation Corp., Farmingdale, N. Y. Benulis was previously project engineer on air armament systems for Sperry Gyroscope Co., Great Neck, N. Y.

WILLIAM H. DOERFNER, general manager of Saginaw Steering Gear Division of General Motors Corp., was named 1953 Honor Alumnus of Arthur Hill High School in Saginaw in a ceremony on May 14. The Third Annual Service Award was presented to Doerfner by the school's Quill and Scroll Society in recognition of his industrial and civic achievement and status as Saginaw's "Man of the Year." He has been with GMC since 1919, when he joined the Malleable Iron Foundry as a timekeeper.

BENJAMIN N. ASHTON, president and chief engineer of Electrol, Inc., Kingston, N. Y., has been elected first vice-president of the newly-founded National Fluid Power Association. Headquarters for the Association have been established in Evanston, Ill.

LT. JOHN R. HIGH of the Navy is now aboard the aircraft carrier U.S.S. Oriskany in Pacific waters.

W. A. JENSEN, assistant chief engineer of Reo Motors, Inc., has been named to direct Reo's new military engineering department. Assisting him will be **G. D. TOOKER**, development engineer, and **H. T. INGERSON**, service engineer. All three have been closely associated with Reo's military development projects in the past.

ROBERT E. SCHERR has joined Origins, Inc., Rye, N. Y., as a project engineer.

H. J. PATTERSON, who was previously owner of the Transport Equipment Co., Burlington, Ont., is now operating his own contracting company in Burlington.

ROBERT O. GOSE has rejoined Phillips Petroleum Co., Bartlesville, Okla., as research engineer on rocket propellants. Gose recently completed

SAE Members Are Saying . . .

"Airplanes are so fast today that when you can hear them they're gone—and when you can see 'em they're obsolete." . . . **William P. Lear**, chairman of the board, Lear, Inc., before the Fourth Annual Safety Seminar of the Flight Safety Foundation.

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"The traffic accident death rate in the United States is now at an all-time low. On a per-mile basis, it is safer to drive today than at any time since the motor age began about half a century ago. This is an achievement of which we can all be proud.

"But the growth of motor vehicle use has been spectacular, especially during recent years. So in spite of a lower rate, the total number of casualties continues to increase. The 38,000 fatalities that occurred last year emphasize in a tragic way the need to continue and expand our efforts." . . . **Alfred P. Sloan**, chairman, General Motors Corp., at the Fifth Annual Radio-Television Awards Dinner.

"It is estimated that the development cost for a prototype model turbojet plane may approximate $30,000,000. It is estimated that production models thereafter may cost $3,000,000 to $4,000,000 each. Compare that with the cost of the DC-6, $1,000,000, or the DC-7, $1,600,000." . . . **C. R. Smith**, president, American Airlines, Inc., at the Syracuse University Transportation Conference.

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"It will be hard to catch up with the British on some of the markets they have captured. I don't believe they have been ahead on technical development. Their market lead can be recaptured by American manufacturers with competitive designs in the not-too-distant future. My guess is that by 1960 the market could be evenly divided between us and the British." . . . **Wellwood E. Beall**, vice-president of engineering and sales for Boeing Airplane Co., in an interview for "U. S. News and World Report."

Students Enter Industry

NORMAN H. BELL (Parks College '52) has joined Pratt and Whitney Aircraft, East Hartford, Conn.

WILLIAM TOTO (Drexel Institute of Technology '51) is a production engineer for GMC's Fisher Body Division, Detroit.

PAUL F. McCABE (Northrop Aeronautical Institute '52) is now a co-pilot for Goodyear Tire and Rubber Co., Los Angeles, Calif.

ROY F. LITTLE (Indiana Technical College '52) has joined the American Enka Corp., Enka, N.C., as a design engineer.

RAYMOND J. SACKS (Missouri School of Mines and Metallurgy '53) is a junior process engineer in the production standards department of GMC's Fisher Body Division, Detroit.

ROLAND L. POHLMAN, JR. (Missouri School of Mines and Metallurgy '53) is now with the R. L. Pohlman Co., St. Louis, Mo.

EDWARD N. MAEDER (University of Wisconsin '53) is an engineering trainee for Caterpillar Tractor Co., Peoria, Ill.

SHERMAN L. BREMER (University of Illinois '53) is a sales trainee for GMC's Oldsmobile Division, Lansing, Mich.

ROBERT R. ANTHONY (Northrop Aeronautical Institute '52) is now junior aerodynamics engineer in the aeronautical design department of the Glenn L. Martin Co., Baltimore, Md.

F. J. HERRINGTON, JR. (Carnegie Institute of Technology '52) has joined GMC's Pontiac Motor Division, Pontiac, Mich.

ROBERT D. REED (University of Idaho '53) is now with the National Advisory Committee for Aeronautics in Edwards, Calif.

ERNEST A. ROTTACH (Stevens Institute of Technology '52) is an aero-

Continued on Page 112

OBITUARIES

OSCAR A. LEUTWILER

Oscar A. Leutwiler, professor emeritus and head of the mechanical engineering department of the University of Illinois from 1934 to 1945, died of a heart attack May 31 in Batesville, Ark. He was 76.

A native of Highland, Ill., Leutwiler graduated from the University of Illinois where he earned a B.S. degree in Mechanical Engineering and an M.E. In 1903 he joined the faculty of Illinois and became professor in 1915.

He was author of several textbooks in machine and powerplant design and active in professional societies.

E. CROWELL KNIGHT

E. Crowell Knight died May 12 at the age of 34. He had been ill since last October and in a serious condition since January.

Knight, assistant chief engineer of the Ross Gear and Tool Co., was a 1940 graduate of Purdue University, where he majored in mechanical engineering. He joined the Ross engineering staff in 1943.

THOMAS O. RICHARDS

Thomas O. Richards, head of the executive engineering department of GMC's Research Laboratories Division, died May 17 after a brief illness. He was 53.

He was a graduate of Phillips Academy, Andover, Mass. and the Massachusetts Institute of Technology where he earned a B.S. Degree in General Engineering.

In April 1925 he returned to the Cadillac Motor Car Division where he had worked previously for a year. Later he transferred to the GMC Research Laboratories as a technical clerk.

Two years later, in 1927, Richards became head of the research technical data department and assistant secretary of the new devices committee. In 1937 he was named head of the laboratory control department of GM Research. At the beginning of this year, 1953, he became head of the executive engineering department.

Richards also did public relations work in the field of education and organized personnel studies. He was a member of the Engineering Society of Detroit and the Detroit Yacht Club as well as SAE.

Richards is survived by his wife, Mrs. Ruth Allen Richards and two sons, Allen and Dwight. Mrs. Richards is daughter of William R. Allen, former governor of Montana.

HERMAN HANNI

Herman Hanni, retired general manager of the Scintilla Magneto Division of the Bendix Aviation Corp., died May 22 after a long illness. He was 59.

Hanni was one of the original group of Swiss engineers who established the Scintilla Magneto Company, which had nine employees when the business was started in a Sidney, N. Y. garage in 1925. He was general manager of the firm until it became part of the newly-organized Bendix Corp. in 1929 and continued as general manager of the Scintilla Division of Bendix until 1946. During World War II Scintilla expanded so that it ultimately required 8600 employees to handle peak production volume of $80,000,000 annually.

Following his retirement, Hanni served as a management consultant to Scintilla and in 1947 was named "Man of the Year" by the Sidney Chamber of Commerce.

Hanni is survived by his wife, Marie; a son, Frederick E. Hanni, of Sidney; two daughters, the Misses Dorothy M., of Cambridge, Mass., and Suzzanne Hanni, of Sidney; and two brothers, Walter, of LaConner, Wash., and Hans Hanni, of Solothurn, Switzerland.

CHARLES B. BOHN

Charles B. Bohn, chairman of Bohn Aluminum and Brass Corp., died April 2 in Miami Beach, Fla. He was 73.

The Detroit industrialist was also a director of the Michigan National Bank, the Wolverine Insurance Co., and the Federal Life and Casualty Co. He had been an SAE member since 1919.

Bohn is survived by his wife and daughter.

a two-year tour of duty with the U. S. Air Force, during which he served as a project engineer at Wright Air Development Center, Wright-Patterson Base, Dayton, Ohio.

JEROME S. BUZZARD is now senior product designer on axle assemblies for the Salisbury Axle Works, a division of the Dana Corp., Fort Wayne, Ind. Buzzard was previously senior layout man for International Harvester Co. in Fort Wayne.

CHARLES E. MacDONALD has joined McCulloch Motors Corp., Los Angeles, as design engineer. He was formerly staff mechanical engineer at the Pacific Mercury Research Center, Santa Barbara, Calif.

NOEL R. CORDER is now a junior engineer for Boeing Airplane Co., Seattle, Wash. Corder has recently been serving in the U. S. Air Force, and prior to that was with the International Harvester Co., Chicago.

PAUL J. PAPANEK is now sales manager, aircraft products, for Royal Electric, Inc., Jamestown, Ohio. Papanek was formerly district manager in Washington, D. C., for Jack and Heintz, Inc.

FRED D. GREEN has been promoted to research engineer at Ethyl Corp.'s research laboratories in San Bernardino, Calif. He was previously a technician at Ethyl's Detroit research laboratories.

HERBERT B. HUBBARD has been transferred to Denver, Colo., as staff analyst for United Air Lines, Inc. Hubbard was previously with United Air Lines in South San Francisco, Calif.

L. H. SULLIVAN has been promoted to manager of the lubricating oil sales department of Deep Rock Oil Corp., Tulsa, Okla. Sullivan has been with Deep Rock in Tulsa and Chicago since 1937, except for two years with the Navy during World War II.

RICHARD M. CORS is now vice-president of Champion Motors Co., Minneapolis, Minn. Cors was formerly sales representative for the Kiekhaefer Corp., Fond du Lac, Wis.

FRANK W. WYLIE of the central sales staff of Chrysler Corp. has been named manager of Chrysler's "New Worlds in Motion" travelling engineering show.

JOHN G. McQUAID has been named assistant supervisor of the chassis components section, advanced vehicles department, of Ford Motor Co. Before joining Ford as a project engineer last August, McQuaid was with GMC Cadillac Division's Cleveland Tank Plant.

NEWS OF SAE

VANCOUVER . . .

. . . meeting next month to accent today's cures, tomorrow's hopes.

THE 1953 SAE International West Coast Meeting in Vancouver, Canada, next month offers a program well balanced in participation from Canada and the States. Four SAE Activity Committees (Diesel, Fuels & Lubricants, Truck & Bus, and Transportation & Maintenance) cooperating with the West Coast Sections have assembled a three-day package of topics currently significant to engineers who operate and design motor vehicle equipment.

The Meeting, set for Aug. 17-19, at the Georgia Hotel, Vancouver, is designed to help automotive men in two ways. First, it's loaded with how-to-do-it advice on important fleet operation problems. Second, it brings forecasts of engineering advances now in the works which may be the answers to today's operating gripes.

In the how-to area, two Canadian engineers will give lots of helpful tips on maintaining off-the-highway vehicles. They are R. C. Keast, Hayes Mfg. Co., Ltd., and J. C. O'Brien. W. C. Nostrand, of Winslow Engineering Co., will prescribe for acid conditions in engines. The care and feeding of radiators for power units and heavy-duty vehicles will be spelled out by Fred Young, of Young Radiator.

J. A. Miller, of California Research, has a message on fuels and lubes that will help vehicles withstand the rigors of subzero temperatures. On the management side of things, fleet executives are still looking for the magic formula that tells them when to buy a new truck and get rid of the old one.

Howard Willett, of the Willett Co., will show that it takes nothing more than a well-balanced combination of hard-headed business thinking, engineering facts, and common-sense evaluation.

What's New

Also to be reported at the Meeting will be improvements on the way in transportation equipment. The latest in tire advances will be told by J. J. Robson, of Firestone. On brake developments, J. D. Bennett, of Federal Fawick will hold forth. Al Gilchrist, of Leece-Neville, will bring truck designers and operators up-to-date on a-c and d-c generators. Some fresh thinking on variable transmissions will be served up by Julius Gaussoin, of Silver Eagle Co.

A survey on the small automotive diesel in England and Europe will be presented by A. W. Gosling, of F. Perkins, Ltd. Leyland Motors' John McHugh will give a detailed description of the company's diesel engine.

An analysis of heavy-duty equipment to help improve operational procedures will be made by H. T. Mueller and E. C. Paige, of Ethyl Corp.

General chairman of the Meeting is Harold Puxon.

Harold Puxon, general chairman of the 1953 SAE International West Coast Meeting, Aug. 17-19

YOU'LL . . .

. . . be interested to know that . . .

F. W. ROHDE, Westinghouse Electric Corp., and R. N. DuBOIS, Ford Motor Co., have been named to the Aircraft

APPROVED . .

. . . for publication in full in 1953 Transactions are 59 papers.

IN addition to the 46 papers listed on p. 97 in the April issue of the Journal, the 1953 SAE Transactions will include the 13 papers listed below. This now-annual bound volume will be ready for distribution in September. It will contain about 725 pages.

Aviation Fuel Economy and Quality—Brothers Under the Aircraft Skin
by H. E. Alquist, E. A. Droegemueller, and H. N. Taylor

Calculation of High-Speed Valve Motion with a Flexible Overhead Linkage
by Phillip Barkan

Automatic Control Systems Satisfying Certain General Criterions on Transient Behavior
by A. S. Boksenbom and R. Hood

Instrumentation for Aircraft Gas Turbine Development
by R. E. Gorton and B. E. Miller

Titanium-Alloy Development
by M. Hansen and H. D. Kessler

Overhead Valve Gear Problems
by Ralph P. Horan

Safe Brakes for Passenger Cars
by George T. Ladd and Sidney B. Dew

Wind Effects on Car Stability
by W. E. Lay and P. W. Lett, Jr.

Development of High-Temperature Hydraulic Fluids
by J. C. Mosteller and Lt. John A. King

Designing the Cam Profile for Low Vibration at High Speeds
by R. A. Roggenbuck

Origins of Development of and Specifications for B & R-Air Force Diesel Engine
by E. W. Spannhake

Relationship of Valve-Spring Design to Valve Gear Dynamics and Hydraulic Lifter Pump-up
by M. C. Turkish

Measuring Rate of Fuel Injection in an Operating Engine
by R. J. Wehrman, H. R. Mitchell, and W. A. Turunen

National Meetings . . .

Meeting	Date	Hotel
	1953	
INTERNATIONAL WEST COAST	Aug. 17-19	Georgia Hotel, Vancouver, B. C.
TRACTOR and PRODUCTION FORUM	Sept. 14-17	Hotel Schroeder, Milwaukee
AERONAUTIC MEETING, AIRCRAFT PRODUCTION FORUM, and AIRCRAFT ENGINEERING DISPLAY	Sept. 29-Oct. 3	Hotel Statler, Los Angeles
INTERNATIONAL PRODUCTION	Oct. 29-30	Royal York Hotel, Toronto
TRANSPORTATION	Nov. 2-4	The Conrad Hilton, Chicago
DIESEL ENGINE	Nov. 3-4	The Conrad Hilton, Chicago
FUELS and LUBRICANTS	Nov. 4-6	The Conrad Hilton, Chicago
	1954	
ANNUAL MEETING and ENGINEERING DISPLAY	Jan. 11-15	The Sheraton-Cadillac Hotel and Hotel Statler, Detroit
PASSENGER CAR, BODY, and MATERIALS	March 2-4	Hotel Statler, Detroit
PRODUCTION MEETING and FORUM	March 29-31	The Drake, Chicago
AERONAUTIC MEETING, AERONAUTIC PRODUCTION FORUM, and AIRCRAFT ENGINEERING DISPLAY	April 12-15	Hotel Statler, New York City
SUMMER	June 6-11	The Ambassador, Atlantic City, N. J.
WEST COAST	Aug. 16-18	Hotel Statler, Los Angeles
TRACTOR and PRODUCTION FORUM	Sept. 13-16	Hotel Schroeder, Milwaukee

Powerplant Activity Committee. Rohde is manager of quality control of the Aviation Gas Turbine Division at Lester, Pa. DuBois is chief product engineer with Ford's Aircraft Engine Division . . . T. H. MORRELL, chief engineer of Oliver Corp., Charles City, Iowa, has been named to the Tractor and Farm Machinery Activity Committee.

★ ★ ★

PYKE JOHNSON, president, Automotive Safety Foundation, Inc., has been reappointed SAE representative to the National Research Council.

★ ★ ★

At its June meeting, the Council adopted amendments to paragraphs B22, B24, B25, B26, B27 and B28 of the Society's By-Laws, to provide for the rotation of personnel on the Membership, Placement, Public Relations, Publication, Sections, and Student Committees . . . This action is aimed toward carrying out the Council's desire to have as many members as possible participate in the Society's committee activities.

DELANEY . . .

. . . heads new Council group to set up a guide for v-p's

GEORGE Delaney, an SAE Passenger Car past vice-president, has been named chairman of a new Council-appointed committee to develop a "Guideposts for Vice-Presidents."

"Aim is to set down briefly the procedures and points of view which SAE vice-presidents have found most effective in carrying on their one-year function as members of the SAE Council and chairmen of their respective Professional Activity Committees." Practices as regards rotation of Activity Committee membership will be outlined in these "Guideposts," based on reports current v-p's have made to Council about desires and traditional practices in each of their activity areas.

Serving with Delaney on this committee will be: John Moxey, a past Fuels & Lubricants v-p; Wade Seniff, a past Diesel v-p; O. A. Brouer, currently Transportation & Maintenance v-p; and E. G. Haven, currently Aircraft Powerplant v-p. The committee will report its recommendations to the SAE Council.

Program for

SAE International West Coast Meeting

Hotel Georgia Vancouver, B. C., Canada

Aug. 17-19, 1953

Monday, Aug. 17

All technical sessions to be held in the Axtec Ballroom

9:50 a.m.

SAE British Columbia Section Welcomes SAE

Alan B. Reid, Section Chairman

Acknowledgment by SAE President,

Robert Cass

10:00 a.m.

Chairman, **A. P. Nelsen**
H. M. Dingley Co.

Preventive Maintenance of Off-Highway Vehicles

Ralph C. Keast, Hayes Mfg. Co., Ltd.

J. C. O'Brien, MacMillan Bloedel, Ltd.

Need a practical PM program for expensive off-highway equipment? If you're faced with the necessity of keeping maintenance costs to a minimum on heavily-capitalized trucks and trailers operating in tough terrain, this paper will shed fresh light on the means adopted by big log hauling operators in off-highway hauls in the rugged Pacific Northwest woods.

What's New In Tires

J. J. Robson, Firestone Tire & Rubber Co.

Rapid advances are being made in tire technology in the private passenger, truck and bus fields, but these advances bring with them new problems. Studies involving traction wave phenomenon in high speed automobiles and new truck tire designs and materials developed for more mileage and lower operating costs will be revealed in this timely paper.

Prepared discussion by **H. M. Place**, U. S. Rubber Co.

Sponsored by Transportation and Maintenance Activity

2:00 p.m.

Chairman, **B. T. Andersen**
Union Oil Co. of Calif.

Small Two-Cycle Combustion and Lubrication Problems

F. Davison, Industrial Engineering, Ltd.

Marriage and solution of the manufacturer's and operator's problems is more than half the battle. Here's an opportunity to sit down with and help solve combustion and lube problems present in the development of the high-output two-cycle gasoline engines common in the power chain saw field.

Your Engine Can Be Cured Of Acid Indigestion

W. G. Nostrand, Winslow Engineering Co.

Is your motor suffering from over-acidity? Don't reach for the bromo . . . here's a paper that cuts through a mass of evidence to solve problems present in "well head" gas, crude oil, residual, sewage gas, etc. Most, says the author, arises from dissolved sulfur compounds in the fuels. Remove them and engine performance improves. Paper is based on actual field tests.

Prepared discussion by **L. Brinson**, Nordberg Mfg. Co.

Sponsored by Fuels and Lubricants Activity

Tuesday, Aug. 18

9:30 a.m.

Chairman, **J. E. Glidewell**,
Hall-Scott Motor Division,
ACF-Brill Motors Co.

The Small Automotive Diesel in Great Britain and Europe

A. W. Gosling, F. Perkins, Ltd.

Ranging from the development of British and European diesels to manufacturing methods, injection equipment and starting methods used on light commercial, private car and industrial applications, this paper is an up-to-date appraisal of the "small" automotive diesel-overseas edition.

Prepared discussion by **J. Dickson**, Detroit Diesel Engine Division, GMC

Some Recent Notes on the Leyland Development of High Speed Compression Ignition Engines

J. McHugh, Leyland Motors of Canada, Ltd.

S. Markland, Leyland Motors of England

Main theme is design, development and production of British-built compression-ignition engines of higher output and higher operating speeds than those presently being sold in Europe and other parts of the world. Developments include supercharging and mechanical methods of overcoming thermal problems encountered.

Prepared discussion by **L. J. Fageol**, Fageol Products

Sponsored by Diesel Engine Activity

2:00 p.m.

Chairman, **W. C. Heath**,
Solar Aircraft Co.

Post World War II Development in Heavy-Duty Vehicle Brakes

J. D. Bennett, Federal Fawick Corp.

Higher horsepowers and heavier vehicles demand bigger brakes. An up-to-date paper outlining the increased life and performance resulting from new developments in brakes for heavy-duty commercial and military vehicles.

Why Alternator Systems?

A. D. Gilchrist, The Leece-Neville Co.

Why and when should D.C. or A.C.-D.C. power be used on tomorrow's trucks and buses? This paper explains and recommends procedures; completely covers design and cost characteristics in current development demanded by increased vehicle electrical loads.

Radiators for Power Units and Heavy Duty Vehicles

Fred Young, Young Radiator Co.

Heavy-duty radiators combine special structural design with high capacity heat transfer. Surface pressurization may be utilized to increase capacity; prevent water loss. Proper mounting care and maintenance and the use of suitable water and inhibitor are necessary to maintain design capacity and trouble free operation.

Sponsored by Truck and Bus Activity

Tuesday, Aug. 18

Banquet

6:45 p.m. **Axtec Ballroom**

H. A. Puxon, General Chairman of Meeting

H. L. Hinchcliffe, Toastmaster, Shell Oil Co. of Canada, Ltd.

Robert Cass, SAE President

Principal Speaker

Reverend William Hills

Wednesday, Aug. 19

9:30 a.m.

Chairman, C. A. Dillinger,
Tokeim Pump Co.

The Three E's of Operation and Maintenance—Engineering, Equipment, Education

H. T. Mueller, Ethyl Corp.

E. C. Paige, Ethyl Corp.

What's ahead in fuels as engine power outputs climb? Paper reports advances in fuel technology as related to today's roads, altitudes, transmissions and maintenance techniques with emphasis on low operating costs.

Fuels and Lubricants Solve Cold Weather Driving Problems

J. A. Miller, California Research Corp.

Problems and their solution experienced in severe winter weather conditions are coupled with data on special fuels and lubricants developed to reduce operating costs and equipment maintenance in sub-zero temperatures

Sponsored by Fuels and Lubricants and Transportation and Maintenance Activities

2:00 p.m.

Chairman, **D. F. Hume**,
Ernie Majer, Inc.
Secretary,

How Long Should You Run a Truck to Get the Lowest Combined Depreciation and Maintenance Cost?

H. W. Willett, Jr., Willett Co.

Most economical: High depreciations and low maintenance costs or low depreciation and high maintenance? An old but recurring question effectively aswered with numerous tables based on actual operating practices. Paper outlines proper replacement ages and schedules.

Prepared discussions by **Robert Wilhelm**, Wilhelm Truck Leasing Co., and **J. L. S. Snead**, Consolidated Freightways, Inc.

Gear Jammers—Three Hands Cowboy

J. Gaussoin, Silver Eagle Co.

A project to encourage better understanding of where power losses occur between truck engines and wheels. Showing need for further study of tests already made.

Sponsored by Transportation and Maintenance Activity

TECHNICAL COMMITTEE *Progress*

Jets Demand A Whole New Species Of Aircraft Fuel and Oil Systems

FUEL and oil systems on today's jet planes are pulling their share of the load, but the inevitable design stumbling blocks are making the going tougher and tougher. That's why a new SAE Aeronautics Committee has come into being. Called Committee A-16, Aircraft Fuel and Oil Systems and Equipment, this group hopes to clear some of these design problems out of the way.

Actually, the birth of jet planes ushered in a new era for designers of fuel and oil systems. Overnight, the well established systems they had achieved in piston aircraft suddenly became totally inadequate . . . and a new species had to come into being for jet aircraft. Naturally this brought a whole flock of design problems—some of which still exist today. What's more, the trend toward faster, higher-flying jets is constantly introducing even more complex problems.

Which of these problems can benefit from joint action by industry? What are possible solutions to them? Where should standardization be promoted?

A-16 has not only set out to answer these questions, but also to go one all-important step further. It plans to pursue solutions to these problems. In short, the aim of this new group will be to work toward obtaining the most efficient combination of jet powerplants and their fuel and oil systems.

One of the first things the members of A-16 saw fit to do at their initial meeting on May 5-6 was to make sure they will always be talking the same language! Thus they decided to establish a glossary of terms used in fuel and oil system work.

Committee chairman P. H. Jones, of North American Aviation, also got the ball rolling on a number of other specific projects. Among these are surveys to determine: the feeling of A-16 members on the proposed MIL General Specification for Fuel System Components; how industry feels with regard to bend radius for fuel system lines; if A-16 members consider present standards for fuel line flexible couplings realistic and, if not, how to make them so.

These are A-16 members who will be consulted in these surveys: K. Bragg, Northrop; J. Fitzpatrick, Boeing; R. S. Forrester, Aero Supply; J. Karanik, Grumman; R. LeBow, Parker Appliance; E. R. Schuberth, Lockheed; C. R. Starr, Douglas; L. E. Tomlinson, Hydro-Aire; H. Waller, Republic; W. Whitesides, Douglas; H. Nevin, United Air Lines; and G. Whittaker, W. R. Whittaker Co.

Europeans Interested In Trying Boron Steels

EUROPEAN metallurgists are eager to learn about American practice and viewpoints on alternate steels, Harry B. Knowlton and Louis J. Rohl found on their recent seven-country trip.

Knowlton told SAE Division VIII at their May 18 meeting that he and Rohl were most cordially received everywhere they went, although not all their listeners agreed with them. Cooperation isn't limited to the SAE or the USA, they saw when they toured Germany, Austria, Italy, France, England, Holland, and Belgium.

The two men made the trip under the auspices of the Mutual Security Agency and its associate, the Organization for European Economic Cooperation. Knowlton is chairman of Division VIII (the Boron and Alternate Steels Division of the SAE Iron and Steel Technical Committee). He is also chief materials engineer of International Harvester Co., which has successfully switched to boron steels for 70% of its alloy steel tonnage and uses more boron steel than any other company. Rohl is chief metallurgical engineer of US Steel, the largest steel producer. He discussed with the Europeans problems of making boron steel.

To groups of metallurgists in each country, Knowlton explained how, through the SAE Iron and Steel Technical Committee and the Alloy Bar Committee of the American Iron and Steel Institute, the National Emergency Steels were set up during World War II. The NE steels gave perfectly good performance and at the same time conserved alloying elements. The result was higher production of satisfactory military materiel. All this was accomplished by setting up new steels with hardenability equivalent to the previous standard steels, Knowlton pointed out.

More recently, the same principle has been applied to the creation of boron steels, Knowlton reported to the

1953 SAE Technical Board

Earle S. MacPherson, Chairman

P. C. Ackerman	E. G. Haven	C. E. Mines
D. P. Barnard	R. D. Kelly	M. E. Nuttila
H. W. Browall	R. P. Lewis	F. N. Piasecki
G. E. Burks	W. G. Lundquist	E. W. Tanquary
C. A. Chayne	A. F. Meyer Jr.	B. G. Van Zee
H. E. Churchill		W. M. Walworth

Europeans. Early adoption of these steels has been facilitated through the open forums or "experience meetings" of Division VIII.

Some Europeans are already trying boron steels, Knowlton discovered. The Fiat plant at Turin, Italy turned out a 20-ton heat of 86B45 in one of their electric furnaces. Rohl observed the manufacture of this heat. Fiat has two 60-ton and several 20-ton electric furnaces.

Metallurgists at the Volkswagen Werke are also very much interested in boron steels. Located in Wolfsburg just six miles from the Iron Curtain, near Braunschweig, they are determined to succeed. To fail would be to provide propaganda for the Communists.

The British Iron and Steel Institute did Knowlton and Rohl the honor of extending its meeting a day to hear their story and adding a short English paper on the same subject to their program. Interested as the British were, some of them found it difficult to believe that hardenability specifications could be used in place of their standard tensile and impact data.

Knowlton feels that the ideas he and Rohl advocated may take hold in some spots. Any conservation we or our allies can achieve aids the entire free world. And regardless of whether anyone uses boron steel, the effort did bring together technical men of different countries in two general meetings in Paris for discussions like those SAE has offered for years.

Besides appearing at the meetings arranged by the individual countries and at the two international meetings, Knowlton and Rohl visited five steel mills, five factories, and six laboratories—all in the 26 calendar days from April 13 to May 8.

These reports have been approved recently by the SAE Technical Board . . .

PASSENGER-CAR TRAILER COUPLINGS—A revision in the SAE Recommended Practice for Passenger-Car Trailer Couplings. Developed at the request of the Engineering Committee of the American Association of Motor Vehicle Administrators, this revision includes new information on the attachment of couplings and location of the hitch.

TIRE TERMINOLOGY—A lexicon on motor vehicle tire terminology prepared by the SAE Riding Comfort Research Committee. These simple, short definitions will later become the seventh chapter of the committee's Ride and Vibration Terminology—a report that aims to have suspension engineers "talking the same language."

The first six sections of this report are available now from SAE Special Publications Department as SP 6A, Ride and Vibration Terminology. Price: 50¢ to members, $1 to nonmembers.

POWER TAKE-OFF DRIVES—An SAE Recommended Practice for Agricultural Tractor and Implement Power Take-Off Drives. Prepared by the Farm Equipment Institute Advisory Engineering Subcommittee on Power Take-Off Drives, this report was recommended for adoption as an SAE recommended practice by the SAE Tractor Technical Committee. It is expected to assist manufacturers of agricultural tractors and implements in providing suitable means for power transmission from tractor to implement.

Filter Contaminant Tested Cooperatively

THE Filter Test Methods Subcommittee is embarking on a test program to determine reproducibility of results with a contaminant under consideration for standardization.

The contaminant, known as "SOFTC No. 1" and pronounced "soft see," has been made up under the subcommittee's supervision from sludge taken from used crankcase oil.

Nine laboratories will run tests on contaminant from the same batch, using the same carefully devised test procedure. Each lab will test three filter elements for 100 hours each, on a one-shift-per-day basis—which amounts to about seven and a half work weeks of test time.

After all the tests have been run, a subgroup will study the results to establish whether or not the contaminant is suitable for standardization as a filter-test medium.

This series of tests is designed to uncover reasons for poor correlation among results reported by five labs in a series of tests run last spring. Subcommittee members suspect that either (1) the method of storage and agitation of the raw dirt stock or (2) possible differences between dirt samples used, or both, may account for the differences in results of the earlier tests.

When the tests on SOFTC are complete, the subcommittee plans to study other contaminants, including a synthetic contaminant.

Although the Subcommittee has only recently been constituted as a subcommittee of the SAE Engine Committee, it has been functioning informally, without SAE affiliation, since 1948.

Subcommittee members include: W. A. Hunter of Chrysler as chairman, R. J. Pocock of Ford as secretary, R. C. Beckett of Walker Mfg., S. L. Earle of the Naval Engineering Experiment Station, F. B. Hunt of the Detroit Arsenal, W. S. James of Fram, E. D. Kane of Cuno Engineering, C. L. Lauer of AC Spark Plug, and H. R. Otto of Purolator. For the current test program, Ford is furnishing the contaminant, Fram the dirt agitator sumps and test oil, and Purolator the filter body and elements. The cooperating labs are those with which the Subcommittee members are associated.

SAE Section Meetings

Inspect Steel Plant

• Dayton Section
T. L. Deger, Field Editor

May 22—A plant tour through the Middletown Plant of the Armco Steel Corporation provided an interesting highlight of the year's activities for the Dayton Section.

The Middletown Plant is the parent plant of the American Rolling Mills, more widely known as Armco, and specializes in making special steels for exacting uses. Some of these specialties are electrical steel sheets; steel sheets that can be welded to zinc, paint, aluminum, porcelain, plastics; wide, deep-drawing steel sheets with mirror-smooth surfaces; special steels and irons with corrosive-resistant properties; high-strength steels; and steels that are stainless.

Armco also specializes in steel making processes and has pioneered the development of the continuous process of rolling iron and steel sheets. These Armco processes and operations were viewed in their entirety by members and guests of the Dayton Section.

Of particular interest were some of the facts and figures concerning raw materials, fuel, and so forth, used annually at the Middletown Plant: 145,000 tons of coal; 564,000 tons of molten iron; 1,037,500 tons of scrap; 8 billion cubic feet of gas; 8 billion gallons of water; and 30 million gallons of oil.

No Single Formula For Winterization Problems

• Williamsport Group
Paul Cervinsky, Field Editor

May 4—Each type of vehicle and piece of equipment which must be winterized presents a separate engineering problem involving the proper selection of components, such as heaters, pumps, controls, and so forth, stated **Marc Resek**, vice-president of Perfection Stove Co., before 45 members and guests of the Williamsport Group.

It is possible to start and operate vehicles and equipment in 0 F with special techniques and dilution of lubricants and greases, heated covers, and so forth, but these practices are time consuming, uneconomical and impractical for standby and alert duty. When proper winterization of a vehicle is accomplished, operation is successfully insured and time is no problem.

With our arctic bases and installations becoming strategically more important every day, the program of winterization of vehicles and equipment becomes a great engineering challenge.

Ladies Hear Program On "Horseless Carriages"

• Washington Section
Allen P. Blade, Field Editor

May 19—The final meeting of the season turned back the clock to experiences which the "Old Timers"—including both the automobile and the public—encountered in the early days of "horseless carriages." The program was tuned to the whims and desires of the feminine gender for the many ladies present.

The "little lady" heard about the operation of automobiles in the early days of dirt roads, endurance runs and "new developments" at the beginning of the century as told and illustrated by an expert panel of automobile "old timers," including **Claude Mahoney**, well known WTOP and TV commentator and news-caster; **Howard Fisk**, special correspondent and former automobile editor of the "Washington Evening Star;" and **Frank Stewart**, president, Standard Automotive Supply Company and past president of the Automobile Old Timers Club.

The panel members were dressed in suitable costumes of the days of early

Officers of the Williamsport, Pa., group for the 1952-1953 season who ran a dinner dance for their June meeting. Left to right they are: D. S. King, Walter C. Jamouneau, E. W. Mueseler, H. E. Epler, Allen Weiss, Paul Cervinsky, W. Ribando, R. B. Ingram, F. G. Rohm, A. E. Sieminski, W. G. Evans, and B. S. Kratzer. As honored guests, Giorgio Vianson, chairman of the board of directors, and Guiseppi Raiteri, chief production engineer of Piaggio & Co., Genoa, Italy, attended the affair

automobiling and as they recalled their experiences slides were shown, some of them original photographs, as well as a whole parade of early vehicles. Each panel member was called upon to give his experiences with regard to roads in the early days, performance tests, Indianapolis and board track racing as well as accessories, including tops, side curtains, windshields, horns, gas and electric lights and generators. A prized collection of brand name plates of early vehicles was on display.

Tom Neil presented outgoing chairman John Hulse with a certificate of appreciation for his splendid work during the past year. The large audience of members and guests joined in congratulations.

Ladies Enjoy Movies, Dancing

• Southern New England Section

A. D. Nichols, Field Editor

May 15—The annual "Ladies' Night" was held at the Wethersfield Country Club as the final meeting of the season for the Southern New England Section. After the banquet, favors were distributed to the ladies. A movie, "Rendevous in the Reef," showing the underwater life in the coral reefs in the Bahama Islands, was shown. Dancing was enjoyed until 12:30.

Valve Problems Discussed At Special Dinner-Meeting

• Western Michigan Section

A. L. Maring, Field Editor

May 6—At a special May dinner-meeting, **Vincent Ayres,** assistant chief engineer for the Eaton Mfg. Co., presented a paper, "Valves and Valve Gear Problems." Valve materials and factors affecting valve life, including a design of the valves and related parts, were covered in his talk.

Ayres also discussed the design of tappets and various types of hydraulic lifters as well as cam shaft design and its effect on the life of the valve.

Shown between the dinner and the regular meeting was a film of the Le Mans 1952 International Sports Car Race. Past-chairman of the Western Michigan Section, M. W. Bolster, arranged the meeting which was of particular interest to members of the trucking industry. E. C. Beck, chief engineer of the Sealed Power Corp., was the technical chairman for the evening.

Last Meeting of the Season Held by Atlanta Group

Guests and members of the Atlanta Group at the last meeting of the 1952-1953 season held May 18. The Atlanta Group joined forces with the Institute of the Aeronautical Sciences for the occasion, and **Richard L. Coffey,** turboprop sales engineer for the Allison Division, GMC, presented a paper "The Propeller-Turbine Engine."

Guests and members in the picture are: Front Row (left to right) —Zack T. Layfield, Jr., SAE Atlanta Group chairman '53-'54; Karl H. Nonweiler, SAE Atlanta Group chairman '52-'53; Guest Speaker Richard L. Coffey; George Baughman, chairman, IAS Atlanta Section; Mrs. Frances Pitts, Wagstaff Motor Co., Inc.

Second Row (left to right)—Jack S. Reid, SAE Atlanta Group vice-chairman '53-'54; Miss Edith Lively, Secretary, IAS Atlanta Section; Randolph Whitfield, SAE Atlanta Group past-chairman; Elmer Sanborn, SAE Atlanta Group treasurer '52-'53-'54; Prof. George Williams, vice-chairman, IAS Atlanta Section.

Incoming Officers Congratulated at Social

Incoming 1953-1954 officers of the San Antonio Division of Texas Section being congratulated May 14 at a social which concluded the 1952-1953 year's operation. Approximately 150 members, wives and guests were present despite rainy weather. Appearing here are left to right: Incoming Secretary Ludwig L. Motulsky; Incoming Treasurer Howard V. Pierce; Incoming Chairman E. W. Berry; Chairman J. J. Brett; and Incoming Vice-Chairman George Zerschausky

Met Section Enjoys Golf Outing

One of the groups of Met Section members and their wives at the May 15 outing was (left to right) J. Edward Schipper, Jr., chairman of the outing committee, and his wife; Harold Strohman, and Mrs. J. Edward Schipper, Sr. At right are William E. Conway and Mrs. Conway

Outing Chairman Schipper, refused to rest on his laurels as planner of the outing, and sat down at the piano to entertain the guests. At right, one of the many foursomes that took to the greens, undaunted by cloudy skies and occasional rain

Radar Checks Speed Of Cincinnati Motorists

• Cincinnati Section

Edward B. Lohaus, Field Editor

May 25—Highway safety is a problem growing greater each day with increasing fatalities. Many of these fatalities are due to excess speeds, and controlling vehicle speed is considered a major problem, said **James Hearn**, electronic engineer of Cincinnati's department of safety.

Many devices and techniques have been developed in the past to measure the speed of motor vehicles. Some were quite satisfactory, but most of them required elaborate setup procedures and the resulting speed readings had to be obtained by referring to charts or graphs.

Several years ago an ingenious device known as the Electro-Matic Speed Meter was developed by Eastern Industries, Inc., of Norwalk, Conn. This meter is a by-product of the extensive radar developments made during World War II and makes use of the length of a radio wave as its measuring stick. The use of radar techniques, plus reliable electronic circuits to measure time, have resulted in a very practical speed meter. It gives direct linear readings of speeds up to 100 mph, and its accuracy is high and can easily be maintained in rough field usage. It is light in weight, portable, can be operated from the car battery or 110 v AC, and its set-up time is a matter of five or six minutes.

The radar speed meter operates on a microwave frequency of 2455 megacycles. Since microwaves behave similarly to light, they can be directed toward a given object or a moving vehicle. The $12 \times 12 \times 7$ in. box shown in the photo houses the miniature transmitter and receiver. The trans-

mitter is continuously sending out radio frequency energy. Some portion of it striking a moving vehicle is returned to the receiver in accordance with the radar principles.

Since the vehicle was in motion, the Doppler principle is also involved and the length of the returning radio wave has changed in length. Stated differently—moving targets in the path of a radio wave cause a shift in length of the reflected wave according to the Doppler principle. Similar conditions exist with sound waves, as shown by the wail of a train whistle as it passes an observer. It is the wail produced on the radio frequency wave by the moving vehicle that is evaluated in the reading of the radar speed meter. By conventional super-hetrodyne action, the Doppler beat-note appears in the output of the receiver. This is fed to the 9×9×6 in. box known as the indicator-amplifier, which contains the limiters and electronic counting circuits and meter reading in miles per hour. The photo also shows the power unit (10×5×4 in.) and the graphic recorder which makes a permanent record of the speed readings.

In operation, the transmitter-receiver unit is set up near the edge of the roadway. In many cases it is placed on the left rear fender of a police vehicle, directly facing the oncoming traffic. Its operating zone is approximately 150 feet. As a car passes through the operating zone, its speed is read directly on the meter. As the car passes, the operator of the radar car notes the license number and make of car and radios this information to a second car parked several squares or a half mile ahead. The second car, often referred to as the retreiver car, stops the motorist and issues a warning or citation tag as the case warrants.

Autronic Eye Dims Headlights

• Twin City Section

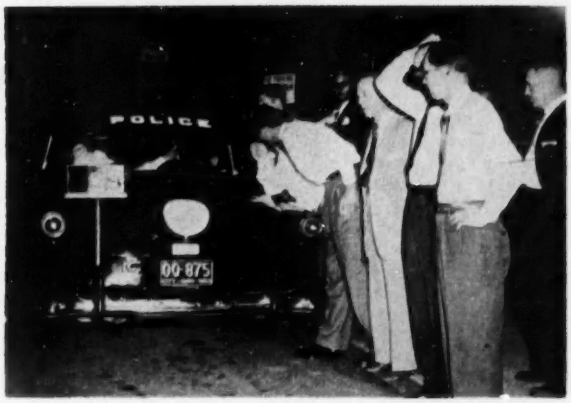
D. D. Hornbeck, Field Editor

May 13—"Highway safety can be markedly improved through use of the 'Autronic-Eye' automatic headlight control," according to **Donald P. Driftmier,** sales engineer of GMC's Guide Lamp Division. Headlight glare has been a continuing problem ever since electric headlamps have been used on automobiles. A beam which illuminates the road far ahead for safe driving is too bright for the approaching driver.

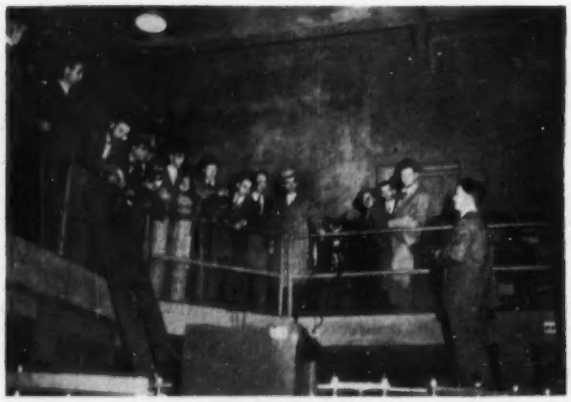
At first we had only one beam, and a resistance was switched in and out of the electric circuit to make the beam "dim" for approaching cars. Later we had headlamps with two beams; an upper beam designed for clear road driving and a lower beam designed to reduce glare when passing.

The glare problem is now largely a matter of proper headlight usage. However, all drivers are not willing to devote sufficient attention to the job of proper dimming. A few drivers do not dim until they are signaled, and

Donald P. Driftmier demonstrates GMC Guide Lamp Division's automatic headlight lowering device to Twin City members W. E. Swenson, B. J. Robertson, and D. D. Hornbeck at the May 13 meeting



At the May 25 meeting of Cincinnati Section, James Hearn of the Cincinnati Department of Safety gave members the lowdown on the city's radar speed control device. At left, Hearn explains the apparatus. At right, members watch the speed meter in action



Members of Indiana Section inspected the laboratories of Purdue University during the April 16 meeting. At left, Dr. Palfrey of Purdue explains the syncrotron. At right, Mr. Radavich shows members how the electron microscope is used

Newly-elected officers of Salt Lake Group look forward to a good year as they look over a list of prospective members at the May 4 meeting. Left to right: Vice-Chairman William B. Littreal, Chairman Richard E. Ostlund, and Secretary-Treasurer Wayne M. Gersen

A change in tempo awaited SAE President Robert Cass (at wheel) when he stepped from his plane into a 1917 White touring car provided by members of Oregon Section for Cass's May 13 visit

others may drive constantly on the lower beams to avoid using the foot switch. Both habits are dangerous.

Since experience indicated that it was hopeless to get drivers to pay proper attention to headlight dimming, either through education or law enforcement, it appeared that the solution lay in automatic headlamp control devices—if they could be made to function properly. The outlook was far from encouraging when considering that the brightness of the oncoming beam would be, of course, many times brighter than that of the oncoming lower beam—not to mention the various light intensities of a variety of models of varying age and vintage.

The initial problem was to develop something that was sensitive enough—something that would dim for lower beams at a safe distance. Satisfactory sensitivity was achieved by using a multiplier phototube which is capable of about one million times the sensitivity of standard vacuum phototubes. It was found, however, that as sensitivity was increased, extreme variations in brightness of oncoming headlamps was not nearly as serious as anticipated because very few roads are straight and level for any distance.

However, as this problem was solved, other problems of optics became apparent and had to be overcome. It was found that a variety of reflective roadside signs, as well as bright moonlight, would cause the headlamps to be automatically lowered. The first was largely overcome through proper optical design and masking, while the latter was reduced through use of an amber filter to remove most of the natural light, rich in blue.

Driftmier indicated that public acceptance of the "Autronic-Eye" unit has been unusually good, considering that an owner's first thought is that he is spending money for a device which only benefits the other fellow. However, he quickly learns that the

device does even more for him than for the approaching driver; he finds that it gives him an upper beam more often than ever before in spite of the fact that it always dims for the approaching cars.

Ladies' Night a Success in Western Michigan Section

• Western Michigan Section

A. L. Maring, Field Editor

May 16—The Section's annual ladies' night, held at the Prospect Point Hotel on Spring Lake, was a successful event with nearly 150 people attending. A smorgasbord at 7:00 p.m. was followed by a dinner at 8:00 and dancing from 10:00 until 1:00 a.m. The ladies were supplied with corsages as part of the arrangements made by Stan Bourdon of the Muskegon Piston Ring Co., meeting chairman.

Three student speakers shared the limelight with Illinois Institute President John V. Rettaliata at the April 23 student meeting of Chicago Section. Left to right are Verne Sprunger of Aeronautical University, William Crane of Northwestern, Dr. Rettaliata, and Joseph Catterini of Illinois Institute of Technology, whose paper on "Buick's New Power Steering" was judged best of the student presentations

Economy Run Winner Gets 27 Miles per Gallon

• Kansas City Section

Samuel Melo, Field Editor

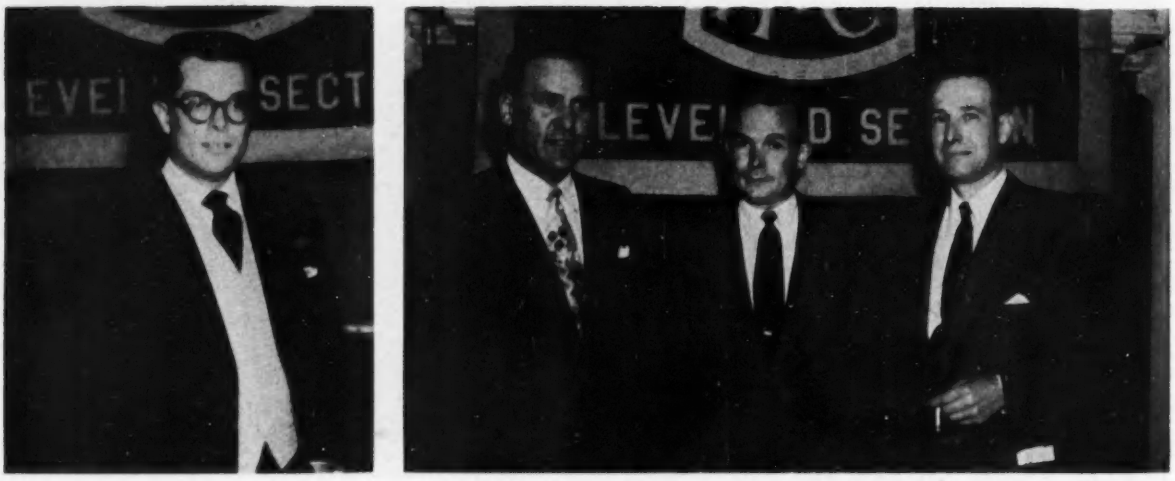
May 13—Undoubtedly the biggest and most successful meeting of the year featured **Frank C. Meunier** of General Petroleum Corp. and **Les Viland** of the Ford Motor Co. as speakers. Meunier is the man responsible for the Mobilgas Economy Runs, and Les Viland is the winner of this year's Los Angeles—Sun Valley run.

Meunier explained that the Mobilgas economy run, while of great promotional value to the Socony-Vacuum Co., was organized primarily to prove dramatically to the American public that safe driving is economical driving, and that a tremendous fuel economy is potentially available in every American car, if the public would just take advantage of it. The outstanding mileages obtained in this test (27.0335 for the winning 6-cylinder Ford Mainliner and 22.2869 average for all cars) were due to no tricks or methods beyond the reach of any automobile owner. They were possible, exclusively, because of (1), condition of cars, (2), drivers' ability, and (3), use of the proper fuel. While all state and municipal speed limits were meticulously respected, the average speed for the whole run amounted to 44.7115 mph and some of the boys hit 75 on no-limit stretches of good road. This average speed, certainly just as high, or higher, than Joe American gets from his family sedan while motoring to his favorite vacation spot, was reached without even coming near to jeopardizing absolute safety, under normal traffic conditions, through towns, hills, mountains and valleys, on good, bad or indifferent roads, with sunshine and rain—and with the sort of economy that would make rationing unnecessary during wartime and would reduce the fuel bill of the American nation by some $1,800,000,000 annually. To make sure that all rules, regulations and speed laws were respected, the test was conducted under the close supervision of the AAA, and two Cal Tech engineering students rode in each car during the whole run.

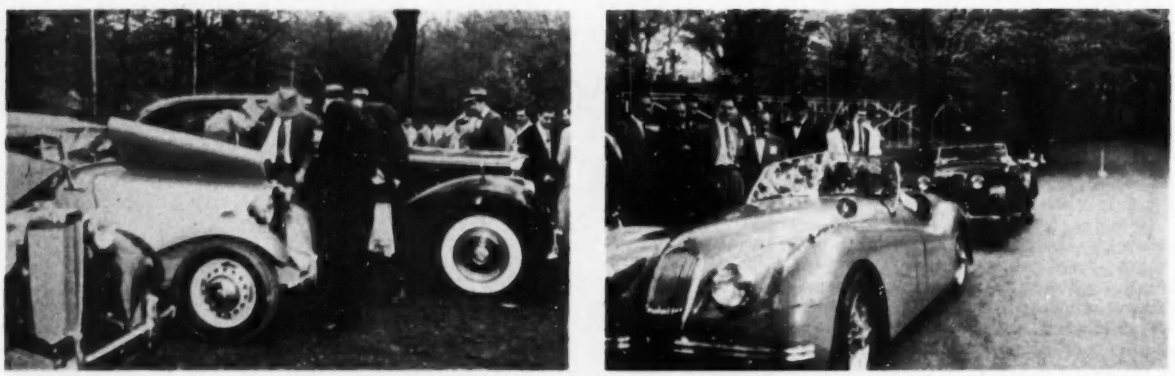
Les Viland, the winner, attributed the secret of his victory to the outstanding economy of the Ford Six "plus damn good gas." He conceded,

Frank C. Meunier (left) of General Petroleum Corp. and Les Viland (right) of Ford chat with Kansas City Section Chairman Lewis C. Mecklenburg (center) at the May 13 meeting at which Meunier and Viland gave members a first-hand report on the 1953 Mobilgas economy run

Sports Cars Discussed, Displayed and Demonstrated at Cleveland Section



Left: James K. Gaylord of Gaylord-Shelton, Inc., told Cleveland Section members about new developments in sports cars at the May 11 meeting. At right are Norman Hoertz, who introduced the speaker, Chairman Robert Cummings, and Vice-Chairman E. K. Brown



A wide variety of foreign sports cars were displayed and demonstrated at the meeting. At left, members peek under the hoods to see what makes the little cars run so far on so little. At right, a Jaguar and an MG wait to take passengers on a spin on the demonstration course

however, that expert driving did help. His prescription for winning included: "Move your right foot the least—remember, the accelerator pump squirts every time—keep the power jet from cutting in unnecessarily. Start and stop gently, anticipate lights and traffic conditions, do not abuse electric accessories—the generator takes about 3 hp at full charge—push the choke in as soon as you can after starting on cold mornings. Keep engine rpm as low as possible at all times."

No coasting was allowed on hills, but some of the boys approached them just so that the overdrive would cut out at the top and the car would freewheel all the way down. Viland does not think this helped any, however, because of the close time limits and the fact that resulting loss of speed had to be made up by more throttle afterwards. Of course, curves were cut when safety and the law permitted it. The specified grade of oil and grease was used in every car, but tires were inflated up to 3 lb above recommended pressures. No carburetor settings, jets or fuel levels were used other than those recommended by the manufacturers for standard conditions —not even high altitude jets. Most drivers did clean the bugs off the paint and windshield, as a national magazine reported, but mostly for appearance's sake. To talk about bugs affecting mileage is getting much too technical for passenger cars.

Frank C. Meunier ended by saying that the miles times weight divided by gallons, the ton-miles formula used to determine the winner, while often criticized, is certainly the most fair and just to one and all. If anybody knows of a better one, he would appreciate hearing about it.

There is no question but that the new rules under which the Mobilgas Economy Run is now conducted make it a true test of economy under normally fast but absolutely safe driving conditions, from which the public at large, the industry and traffic authorities can derive valuable lessons. The route selected this year, the condition of the roads and the vagaries of mother nature, coupled with very demanding time limits, certainly contributed to make the 1953 run as close to normal long distance driving as can be humanly expected of a controlled test.

You Don't Get In . . . You Put Them On

• Cleveland Section

Wilson B. Fiske, Field Editor

May 11—Cleveland Section members had an opportunity to inspect and ride in foreign sports cars at a meeting held at the Lake Shore Country Club. The wide variety of cars on display included such well known makes as the Jaguar, Mercedes Benz, MG, Aston-Martin, Simca, Bentley, Porsche and others. In addition, several cars were furnished by dealers and owners for driving demonstrations over a lengthy course, starting at 4:00 p.m.

A large crowd turned out for the inspection and driving opportunity and for the meeting that followed dinner in the evening. The speaker was **James K. Gaylord**, vice-president of engineering, Gaylord Automotive Division, Gaylord-Shelton, Inc., Chicago. Title of his address was "The Sports Car on the American Scene."

Gaylord, with the aid of his colleague Tom Herbert, discussed the features of foreign sports cars in general and particular makes more specifically. With slides to illustrate, he talked on the developments and performance of these small-engine cars which have exhibited many advantages, including high output for their size. Stability, precise handling, fast pickup, high speed, and fuel economy are outstanding features. Various parts of the little cars were described in detail.

Gaylord was introduced by Norman Hoertz, chief engineer, Service Division, Thompson Products, Inc. Following the talk, the enthusiastic crowd witnessed a sound movie of the famous 1952 Le Mans Race.

Cass Speaker At Central Illinois

• Central Illinois Section

R. B. Appelgate, Field Editor

May 25—SAE President **Robert Cass** was the principal speaker at the May meeting of the Central Illinois Section. Cass spoke in the role of a reporter, bringing out many items of general interest to automotive engineers which he has picked up in his travels through the country.

He stated that engineers must develop substitutes for the metals which are now or may soon be in short supply. One example cited is the trend toward the use of aluminum to replace copper in the radiators and electrical systems of automobiles. The greater abundance of aluminum may lend itself as a substitute for other critical metals.

Cass also said that we are entering an "engineer's world;" the engineer is assuming greater importance—and must assume greater responsibilities in management.

New advancements in automotive power sources were discussed. The advent of the gas turbine engine for trucks as a principal source of power is dependent upon the development of combustion systems which will give better fuel consumption. Improvements in the diesel engine should give up to 20% greater efficiency. The advancements of gasoline engine design were also brought out.

Ray Sackett, as coffee speaker, spoke on the various SAE technical committee activities of which he is the administrator.

The results of the annual election were read to the Section. Officers for the coming year will be: R. E. Kennemer, chairman; H. R. Johnson, vice-chairman; D. Kinkema, vice-chairman for Springfield; J. H. Smith, secretary; H. Bannister, treasurer; and J. W. Vollentine, national nominating committee representative.

President Cass presented John T. Liggett with a Scroll of Achievement for his SAE work.

Chicago Section Hears Students, IIT President

• Chicago Section

R. M. Ladevich

April 23—The fourth annual joint Student-Chicago Section dinner meeting was held on the south side campus of Illinois Institute of Technology. The meeting was chaired by William G. Loots, student chairman of the SAE Branch at Illinois Institute of Technology. Guest speaker was **Dr. John T. Rettaliata**, president of Illinois Institute of Technology, and well-known authority on gas turbines.

In addition to Dr. Rettaliata, three student speakers competed for the Chicago Section SAE Student Award, given annually for the best student presentation. The students, each the winner of the SAE Student Branch Contest in his university, were **Verne Sprunger** of Aeronautical University who spoke on "Using the Turbo-Prop;" **William F. Crane** of Northwestern University who spoke on "Modern Automotive Suspension Systems;" and **Joseph F. Catterini** of Illinois Institute of Technology who spoke on "Buick's New Power Steering."

By unanimous decision of Judges Merrill R. Bennett, James T. Greenlee, and Orville A. Brouer, Joseph Catterini was adjudged the winner of the evening's contest. He was awarded a victory trophy at the May 12 Dinner Meeting of the Chicago Section.

Robert M. Ladevich of Armour Research Foundation introduced the guest speaker of the evening, Dr. John T. Rettaliata who spoke on "Transportation Developments and Gas Turbines."

Dr. Rettaliata predicted that within five years the gas turbine will be commercially applied to land transporta-

Scroll Given to Liggett

Visiting Central Illinois Section for the May 25 meeting, SAE President Robert Cass presented a scroll of achievement to Chairman John T. Liggett

Tells of Future Diesels

C. N. Guerasimoff (left), chief engineer of the Buda Co.'s engine division, chats with technical chairman J. J. Lovretich before speaking on the future of diesels at the April 16 meeting of Oregon Section

Section Meetings

We have received no notification of Section Meetings scheduled between July 8 and Aug. 8.

tion, such as locomotives, trucks and buses. Also predicted was a future widespread use of gas turbines with powdered coal and fuel oil as energy sources. In addition, Dr. Rettaliata stated that within the next few years America will see its first all-jet commercial airliner. If these are not available from American aircraft manufacturers, then the airlines of this country will have to yield to British supremacy in this field, and purchase their aircraft abroad. The all-jet commercial airliner has gained wide acceptance abroad due to speed and comfort offered its passengers. In his closing remarks Dr. Rettaliata issued both a challenge and an invitation—an invitation to American industry to work with technological institutions so that more scientists and technologists may be given the opportunity for scientific education where otherwise it might be impractical or impossible due to limited financial backing; and a challenge to industry to aid our technical institutions in producing the trained personnel urgently needed by the nation.

Cass Proves White's Durability

• Oregon Section

D. T. Saunders

May 13—Flying in from Spokane, National President **Robert Cass** never dreamed that he would find waiting for him at Portland International Airport not only a dozen or more members of the Oregon Section, but a 1917 White touring car in excellent shape for the trip into town. Following his arrival on Tuesday, May 12, President Cass was escorted to his hotel, interviewed by the press, and embarked on a full schedule for the next two days.

On Wednesday evening, a record crowd of Oregon section members and guests filled the Crystal Ballroom at the Benson Hotel in downtown Portland to hear President Cass warn engineers that the world is going to be more difficult for them in general from now on. There must occur a serious readjustment because of material shortages, and engineers in the future will have to design against known sources of materials. We can no longer, Cass said, think of materials as being easily available.

Sounding a warning to the dozen Oregon State College engineering students from Corvallis, Oregon, who attended the meeting with Prof. W. H. Paul, President Cass cautioned them not to think that engineering training is all that the graduate needs. He must know management and understand management's problems.

Portland Mayor Fred L. Peterson presented President Cass with a key to the city, accompanied by a warm request to visit the Northwest again soon.

J. C. Knapp, branch manager of the White Motor Co. in Portland, acted as technical chairman.

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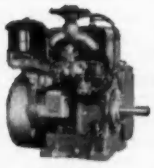
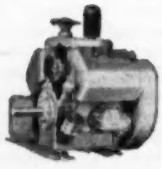


2-cylinder 7 to 14½ hp.



V-type 4-cylinder 15 to 36 hp.

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Tells of Trends In Automotive Diesels

• Oregon Section

D. T. Saunders

April 16—Research and development have brought the modern automotive diesel engine to a point of high efficiency, according to **C. N. Guerasimoff**, chief engineer of the Engine Division of the Buda Co., who presented a paper on "Future Trends in the Requirements and Design of the Automotive Diesel Engine."

Guerasimoff made a special trip from Harvey, Ill., to Portland to address the Oregon section. Near-record attendance demonstrated the interest of west coast members in the subject of the Russian-born speaker who took his degree in mechanical engineering at Stevens Institute of Technology and went on to become chief engineer in Buda's engine division.

In his discussion of what we may expect of the diesel engine in the future, Guerasimoff brought into the picture the development of exhaust gas turbocharging, now being developed for automotive use after years of experience in aviation engines.

Illustrated with numerous slides on performance characteristics, Guerasimoff's paper showed how different designs affect operation and efficiency. While admitting the advantages of the exhaust gas turbocharger for automotive use, he pointed out that there is still work to be done in the field.

J. J. Lovretich of Consolidated

Freightways acted as technical chairman. Lovretich predicts that there will be trial runs of turbocharger equipped vehicles on the west coast in the near future.

Gives History Of Buick Engine

• Indiana Section

V. H. Lewis, Field Editor

April 16—"Why Buick Adopted the V-8 Engine" was the subject of a combined talk by **W. A. Stone** and **J. D. Turlay** of the Buick Division of General Motors at the annual Purdue student meeting of the Indiana Section.

The meeting was a double header, since SAE members spent the afternoon touring the nuclear physics laboratories which are under the direction of Dr. Lark-Horowitz. Dr. Tendon of the Purdue physics department conducted the tour which included such currently interesting equipment as a cyclotron, a syncrotron, a linear accelerator, and an electron microscope. The equipment was in partial operation, giving visitors some idea of the important part Purdue University is playing in our national defense.

Following the dinner Dean Potter, retiring dean of engineering at Purdue, and Dr. Salberg, head of the Mechanical Engineering School, addressed the meeting.

In reviewing the history of Buick engine development, Stone pointed out that, although Buick has been developing and building engines since 1903, not until 1953 have they marketed a V-8 design. The four main reasons given for a V-8 were:

1. Suitability for body styling
2. Compactness, giving lighter weight
3. Greater rigidity, permitting higher combustion loads
4. Better utilization of improvements in tooling

The increased width of the V-8 design over the straight eight necessitated positioning the valves vertical to provide ample clearance for the steering gear. The stroke-to-bore ratio of 0.8, which is about the lowest in the industry, was selected again to keep the overall external dimensions of the engine down. Turlay also stated that short stroke engines have lower inertia loads which are inherently greater than gas-pressure loads, permitting the use of lighter engine parts in spite of the increased horsepower.

Buick adopted 12-volt ignition in the new engine design to provide higher firing voltages. Economy and acceleration were improved because of reduced friction and lighter moving parts. The elimination of the vibration dampener was attributed to a stiffer crankshaft. In explaining the power curve, the speaker pointed out that General Motors rates their engines at 100 F ambient temperature instead of the conventional 60 F because it more nearly represents the usual under-hood temperatures.

We try . . .

. . . to bring you live, prompt news of Section meetings in these pages. Section Field Editors do their best to cover every meeting.

This issue covers all Section meeting reports received in New York by June 12, our deadline for the publication date of July 5.

Tells of Advantages Of Powerglide Transmission

• Texas Gulf Coast Section

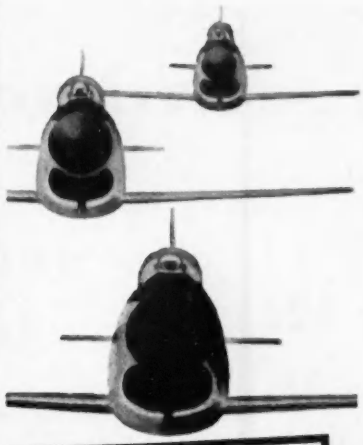
W. B. Tilden, Field Editor

May 14—**W. D. Pidd** of the National Fleet Department, Chevrolet Motor Division, gave a very interesting talk and discussion on "Automatic Transmissions."

Pidd outlined the theory of torque converters, and the design, construction and operation of the Powerglide.

Since the internal combustion engine has a minimum speed at which it can deliver power, some method must be provided to engage and transmit the power of the engine to the driving wheels of the vehicle and with a suitable gear ratio or torque multiplication that will permit the application of sufficient power to start the vehicle moving and enable it to maneuver at low speeds and on grades. Once the car is rolling on level ground the engine develops enough torque to keep it moving.

Pidd stated that in the conventional passenger car, this is accomplished by means of a friction type clutch coupled to a conventional shift type transmission. Engagement between the engine and the drive line is accomplished through the clutch. Gear reduction or torque multiplication is accomplished



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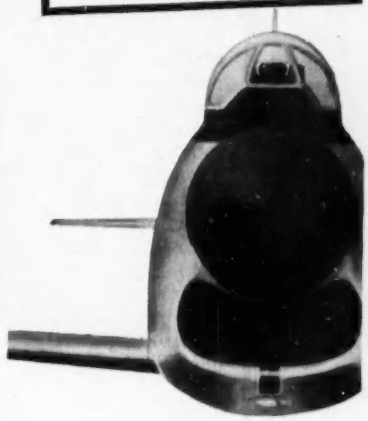

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through manually shifted gears usually providing a direct drive connection, two forward reduction ratios, and a reverse reduction gear.

The ideal transmission is one which will automatically provide a suitable speed or power ratio between the engine and the driving members to meet all driving conditions without any thought, skill or manipulation on the part of the driver. Chevrolet's Powerglide transmission meets these ideal qualifications because it offers a combination of torque multiplication in its torque converter and an automatic shift range in the transmission which automatically provides up shifts from low range to cruising range and downshifts from cruising to low range when necessary to meet various road and traffic conditions.

In conclusion, Pidd stated that all automatic transmissions incorporating a fluid coupling or torque converter cushion the driving and reaction loads between the engine and the car, thus reducing the stresses imposed on all components; consequently maintenance requirements should be reduced to a minimum. Automatic transmissions also compensate for lack of driving skill on the part of the driver. It makes the poor driver good, and makes the good driver better in his handling of the vehicle, thereby reducing the effect that the driver has on the life of the vehicle.

Cummins Racer Tested in Wind Tunnel

• Indiana Section

V. H. Lewis, Field Editor

May 21—The story of the Cummins diesel race car was presented to the Indiana members and guests at the annual "500 Mile Race" meeting by **Don Cummins**, vice-president, and **N. M. Reiners**, research manager, Cummins Engine Co. The presentation was in the form of a colored sound movie covering the entire history of the race car from its inception to its final retirement.

Interesting highlights of the story were the early problems necessitating the positioning of the engine on its side to provide a low silhouette. The removal of weight from the car was a never ending problem right up to the final completion time. The handicap of the excess weight was partially overcome by offsetting the cockpit to provide a counter balance on the turns.

The acceleration problems involved with high turbocharger speeds (48,000 rpm) were solved by providing a very high idling turbo speed. The actual charger speed range was from 20,000 rpm no-load to 48,000 rpm full load. To illustrate the thoroughness to which the engineers carried the development, authentic wind-tunnel tests were con-

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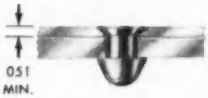

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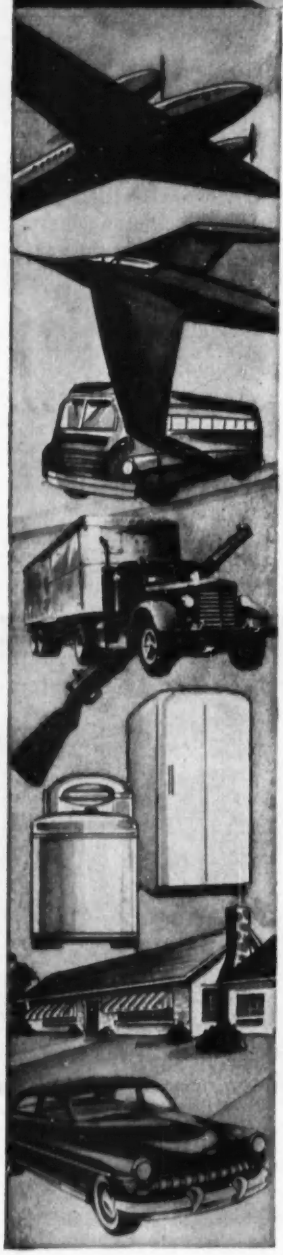

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ducted to determine the ideal body contour offering minimum drag.

Although the car was forced from the race because of blower trouble, the Cummins Co. was well satisfied with its performance and with the fact that they could produce exceptionally high speed and power in diesel engines of surprisingly small size.

Peripatetic Production Of Nash-Healey Sports Car

• St. Louis Section

E. E. Wallace, Field Editor

May 21—A joint dinner meeting of the Institute of Aeronautical Sciences and the St. Louis Section of SAE heard **Earl L. Monson**, chief development engineer of Nash discuss "The Nash-Healy Sports Car," and had the opportunity of examining one of them.

Monson explained how the Nash-Healy developed from the attempt to re-establish Nash's foreign car market, particularly in England. In other countries, the bans on car imports are avoided by shipping cars knocked-down and assembling them locally. In England, however, the austerity programs permit sales of only 80,000 cars a year. In expectation that this program could change, the Nash management decided to make a connection with an established British manufacturer.

At the same time the Healey Motor Co., Ltd., had decided that use of an American engine would improve their competitive position. As a result of tests, the Nash Ambassador engine was chosen as the most suitable for their needs. A mutually desirable connection was soon established in 1950.

At this time the sports car was beginning to be more and more popular in this country. Foreign sports car sales were increasing rapidly. A car with the roadability and handling characteristics of the Healey with an American engine, which could be serviced and maintained at any Nash dealer, appeared to be a natural.

In 1951, approximately 100 of these cars were built. However, while sound mechanically, the car lacked the styling desirable in the American market. About this time, Pinin Farina joined the Nash styling staff. He turned out a restyled prototype body in his Torina, Italy, plant that more than overcame any styling deficiency and was adopted for the 1952 and 1953 model.

As a result, Nash engines are shipped to England, built into a chassis and the chassis then shipped to Italy for installation of the body. The complete car is then sent to the United States for sale.

The Nash-Healey was designed, and has proven, to be an exceptionally fine sports car. It was not primarily designed as a competition car but has

done remarkably well as one. For example, in the 1951 Le Mans 24-hr race, a Nash-Healey finished in 4th position in its class and in 6th position of all cars finishing. In 1952, a Nash-Healey finished 1st in its class and in 3rd position in the overall classfication. Only 17 out of 58 starters finished. The car averaged 91.5 mph for the 24 hour period.

Recently, a production Nash-Healey clocked a maximum of 111 mph in a certified speed test with windshield removed and top down. An interesting fact from the same series of tests shows that with the windshield in place and with top up the car clocked 105 mph while with top down only 100 mph could be maintained.

To date, Monson concluded, the program has shown no direct profits. However, the publicity and increased confidence of the motoring public that has been obtained have more than made up for any monetary losses.

Following Monson's talk and inspection of the car, the group saw films taken of the 1952 British Farnborough air show.

Factors Affecting Exhaust Valve Life

• Salt Lake Group

J. P. Bywater, Field Editor

May 4—Since Salt Lake City is more and more becoming a center for many trucking operations involving heavy loads over long distances and mountainous terrain, **J. Brent Malin's** discussion of exhaust valve life and the factors which control it was of utmost interest to attending members.

Basically valve life depends on valve temperature and the determining factor is a matter of application and maintenance, explained Malin, who is technical representative for E. I. DuPont de Nemours and Co.

A correct analysis of operation and existing engine conditions will determine whether valve temperatures are resulting from engine wear, maladjustment or operating conditions.

Discussion brought out that operators can correct many of their valve conditions by:

1. Correction of the valve wearing points.
2. Proper valve machining and adjustment.
3. Normal performance of engine cooling system.
4. Use of valve rotators.
5. Selection of valves made of higher heat resisting metals.

Chairman Dean Despain concluded the meeting and presented the newly elected officers—Richard E. Ostlund, chairman; William B. Littreal, vice-chairman; and Wayne M. Gersen, secretary and treasurer.

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Students Enter Industry

Continued from Page 91

nautical field engineer for Sperry Gyroscope Co., Great Neck, N. Y.

HAROLD WANASELJA (Stevens Institute of Technology '52) is a second lieutenant in the U. S. Air Force.

THOMAS J. CORBETT (Rensselaer Polytechnic Institute '52) has joined Emerson Radio and Phonograph Corp., New York City, as a design engineer.

JOHN H. BASH (Parks College '52) has rejoined the U. S. Air Force as a second lieutenant in pilot training. Between his graduation in December and entering the Air Force in April, Bash was with Trans World Airlines at LaGuardia Airport, N. Y.

RAYMOND P. STUDNICKI (Bradley University '51) is a second lieutenant in an engineer aviation battalion at Orlando Air Force Base, Fla.

RAYMOND G. FALZON (University of Detroit '52) is a junior engineer in the mechanical engineering department at General Motors Proving Grounds, Milford, Mich.

RALPH O. BRUNT (University of Illinois '52) is a tool engineer trainee for New Holland Machine Division of the Sperry Corp., New Holland, Pa.

HARRY F. HOOLEY (Drexel Institute of Technology '52) is a fire protection engineer with the engineering division of Factory Mutual, Philadelphia, Pa.

ROBERT C. HOLAN (University of Michigan '52) is with GMC's Pontiac Motor Division, Pontiac, Mich., as junior graphic engineer.

ROBERT E. FISHER (Purdue University '52) has joined GMC's Oldsmobile Division, Lansing, Mich., as detail project engineer.

FRITZ C. RUNGE (General Motors Institute '49) is on leave of absence from GMC's Cadillac Motor Division to serve as a lieutenant in the Air Force.

B. G. JONES (A & M College of Texas '52) is a civil engineer for the southern pipe line division of Gulf Refining Co. in Beaumont, Texas.

WILLIAM G. COWDIN (Purdue University '52) is a rocket test engineer for Bell Aircraft Corp., Buffalo, N. Y.

RUSSELL deCASTONGRENE (Purdue University '53) has joined McDonnell Aircraft Co., St. Louis, Mo.

DAVID J. HAYKIN, JR. (Purdue University '53) is a lieutenant in the U. S. Air Force attending electronics school at Keesler Air Force Base, Miss.

DAVID KUENZLI (Illinois Institute

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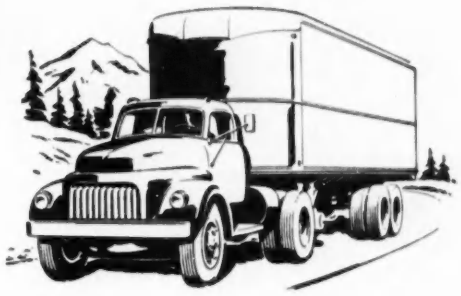

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Students Enter Industry

Continued

of Technology '53) is an engineer for the Pure Oil Co. in Sidney, Neb.

ROBERT D. KLUDT (Wayne University '52) is an industrial engineer for Fraser Machine Products Co., Fraser, Mich.

LAWRENCE J. SULLIVAN (A & M College of Texas '53) is in training with the Stanolind Oil and Gas Co., North Cowden, Texas.

BURTON J. DUCHEK (Missouri School of Mines and Metallurgy '53) is junior engineer on guided missile research for Bendix Products Division of Bendix Aviation Corp., Mishawaka, Ind.

GEORGE J. HOLUBASCH (Parks College '52) has joined Beech Aircraft Corp., Wichita, Kans., as a service engineer.

GEORGE F. TRUDEAU (Michigan State College '52) is pilot aircraft maintenance officer in the U. S. Navy, Norfolk, Va.

WADE Y. SATO (University of Washington '52) is a private in the U. S. Army, Camp San Luis Obispo, Calif.

LEONARD J. MATTSON (University of Illinois '53) is a second lieutenant in the U. S. Army.

WILLIAM ALAN LA ROSA (California State Polytechnic College '52) is liaison engineer for Douglas Aircraft Corp., El Segundo, Calif.

JOHN KLINGLER, JR., (Massachusetts Institute of Technology '54) is a test engineer at International Harvester Co., Chicago.

ROBERT E. McNAMARA (Loyola University at Los Angeles '52) is an installations engineer in the U. S. Air Force.

JAMES D. SHEPHERD (Northrop Aeronautical Institute '52) is with McDonnell Aircraft Corp., St. Louis, Mo., as a stress analyst.

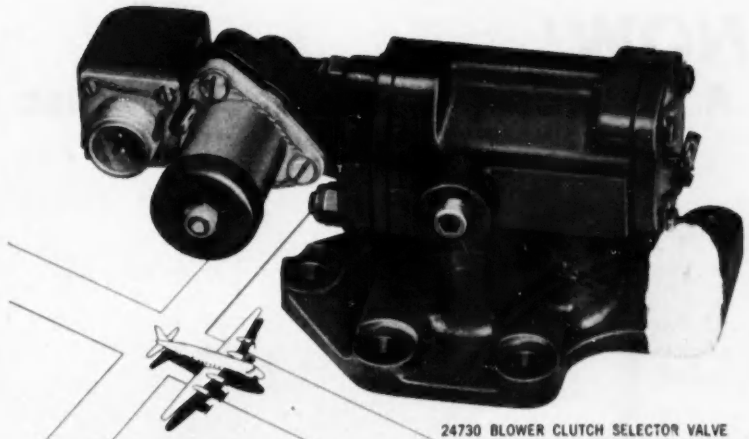
RONALD L. BORTHWICK (Purdue University '53) is an engineer for the Metals Research Laboratory, Division of Union Carbide and Carbon Corp., Niagara Falls.

JOHN R. SECORD (General Motors Institute '53) is an analyst with the Detroit Diesel Engine Division of GMC, Detroit.

RALPH R. SMORKALOFF (New York University '52) is a test engineer for Curtiss-Wright Corp., Wood-Ridge, N. J.

RICHARD E. WAINERDI (University of Oklahoma '52) is a second lieutenant in the U. S. Air Force, Lowry Air Force Base, Denver.

EUGENE A. ROESKE (University of



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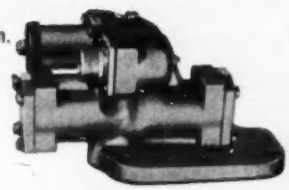
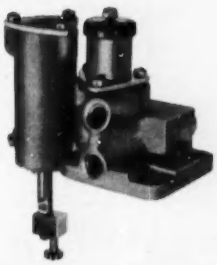
Duty: Continuous.
Solenoid: Single-coil, internally grounded.
Electrical Range: 18 to 30 volts dc.
Current drain: 0.5 amp at 24 volts.
Corrosion resistant construction.

24793 SUPERCHARGER CONTROL ACTUATOR
For use on Wright R3350-30 engine.
Provides positive control of two-speed supercharger with complete immunity to pressure surges in the operating fluid. Durable and dependable.
Weight: 1.75 lb.





26153 SUPERCHARGER CONTROL VALVE
For use on Pratt & Whitney R4360-63 engine.
Directs oil flow from pressure supply to high blower. Rated flow—9 gpm.
Built-in stamina provides dependable performance under extreme vibration conditions.
Weight: 1.9 lb.

25805 SUPERCHARGER ACTUATOR
For use on Wright R1820-103 engine.
Converts hydraulic pressure to mechanical push-pull actuation. Electrically controlled. Combines reliable operation with proven design . . . rugged construction.
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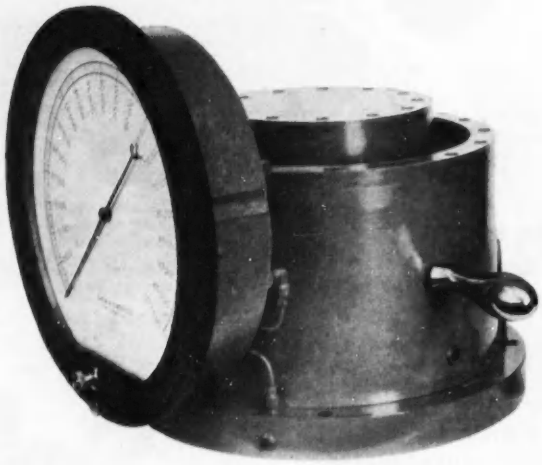

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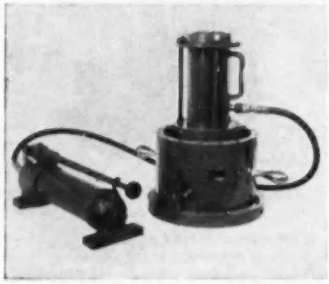

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Max. load_____ % Accuracy required_____

NAME_____

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Students Enter Industry

Continued

Illinois '53) has joined the Sunstrand Machine Tool Co., Hydraulic Division, Rockford, Ill., as a design engineer.

ARTHUR P. AHRENDT (University of Illinois '51) is with Standard Oil Co. of Indiana, Whiting, Ind., as an inspection engineer.

RAY M. LUTZ (University of Virginia '51) is in the U. S. Navy as a lieutenant, junior grade.

WILLIAM C. WRIGHT (Texas A & M '53) is an officer trainee for the Rock Island & Pacific Railroad in Chicago.

DON E. DAVIDSON (Cal-Aero Technical Institute '52) is with Boeing Aircraft Co., Seattle, as a junior engineer "B", design group.

EDSEL A. SPELLMAN (Indiana Technical College '53) is a detailer at the Power Generators, Ltd., Trenton, N. J.

EVERETT L. CASWELL, JR., (Northrop Aeronautical Institute '53) is a design engineer "C" for Sikorsky Aircraft Co., Division of United Aircraft Corp., Bridgeport, Conn.

JAMES R. GIBBONS (University of Washington '53) is in training with Goodyear Tire & Rubber Co., Akron.

MICHAEL J. KICZENSKI (Michigan State '51) is a product engineer at GMC's Ternstedt Division, Detroit.

MAURICE M. WELSH (University of Detroit '52) has joined the Nash-Kelvinator Corp., Detroit, Mich., as a quality control engineer.

DALE R. BURGER (California Institute of Technology) is now in the U. S. Army, stationed at Fort Lewis, Wash.

HENRY CUNNINGHAM (Case Institute of Technology) is with the Cleveland Hobbing Machine Co., Euclid, Ohio, as a demonstrator engineer.

LESLIE A. KLEIN (Indiana Technical College '52) is now with McKinnon Industries, Ltd., a division of General Motors Corp., St. Catherines, Ont., as a product engineer.

GOPALKRISHNA GANAPATHY KUDVA (St. Aloysius College and Madras Institute of Technology) is an engineer with the Canara Public Conveyance Co., Ltd., Mangalore, India.

ROBERT J. LODZINSKI (University of Wisconsin '52) is now with Allis-Chalmers Mfg. Co.'s graduate training course in Milwaukee, Wis.

PAUL A. HOOVER (University of Cincinnati '52) is now a mechanical engineering research assistant at the Naval Ordnance Laboratory, White Oak, Md.

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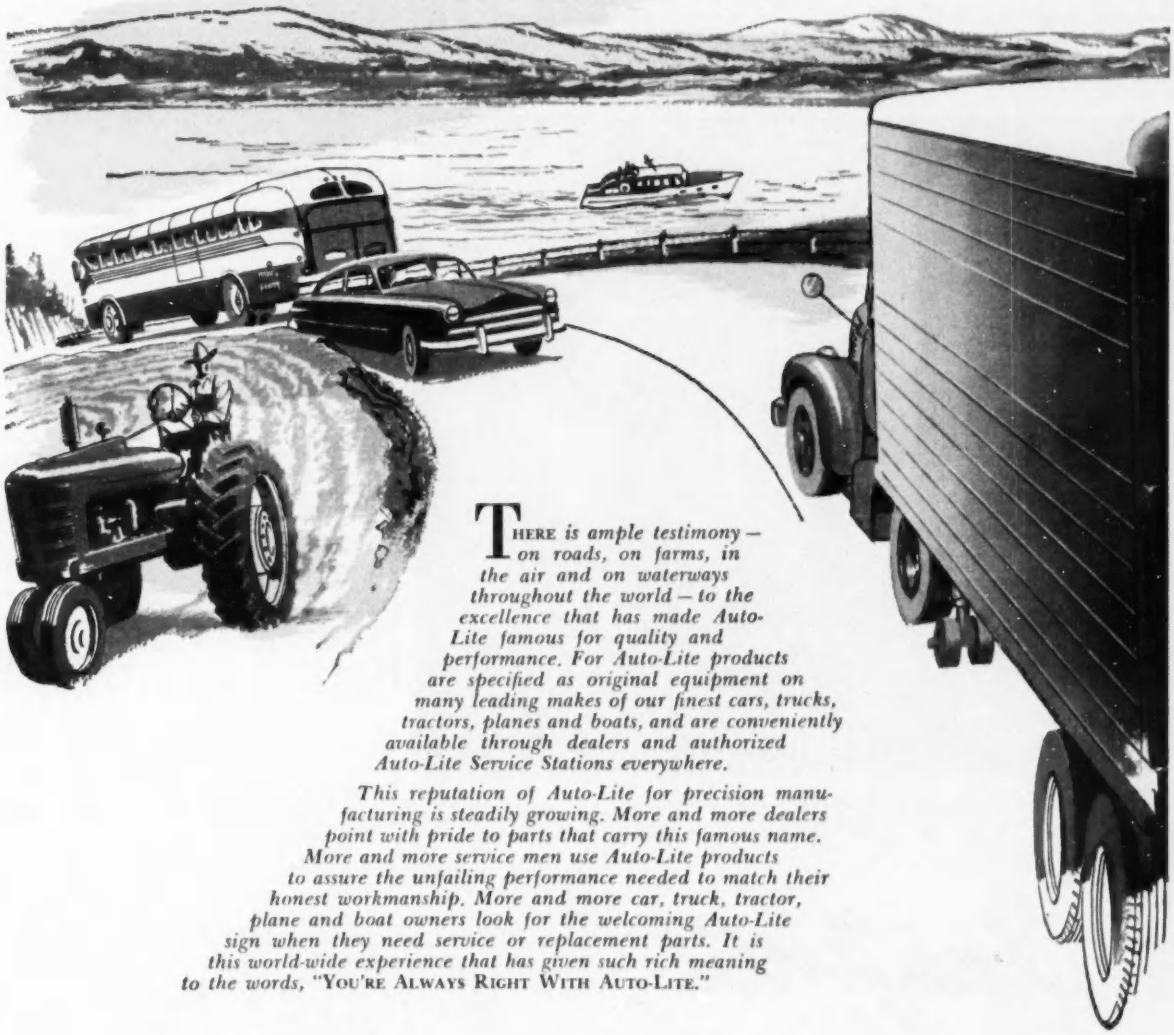

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Planet Final Drive Aids Crawler Operation

Based on paper by

MERRILL BENNETT

International Harvester Co.

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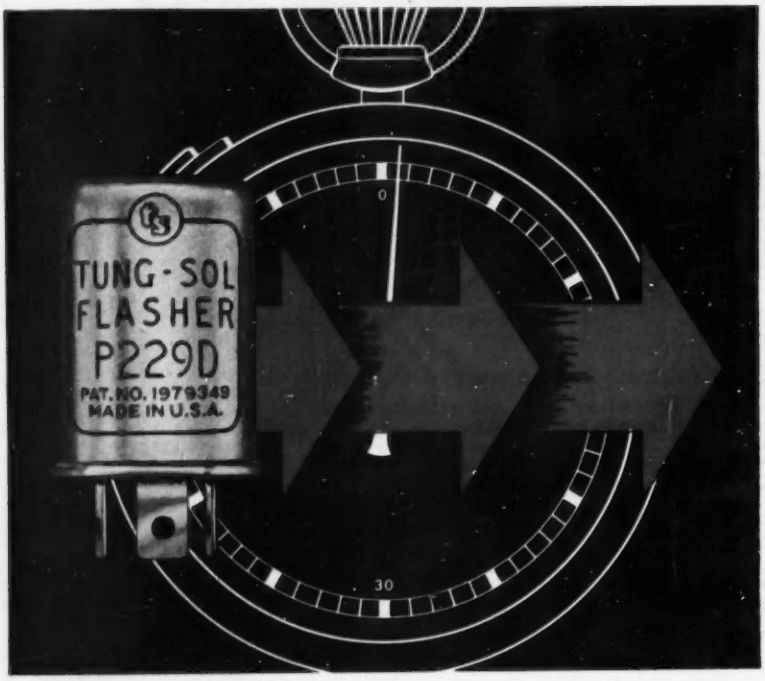
Another feature is a planet power final drive, which consists of two planetary transmissions hydraulically controlled from the tractor seat. Each two-speed planetary transmits power to one track and it is possible to execute a turn with both tracks transmitting power if one planetary is in low range while the other is in high range.

Power on both tracks is a safety feature and also provides additional power when making a turn with a heavy load. (Paper, "The Crawler Tractor in the Construction Industry," was presented at SAE Western Michigan Section, Muskegon, Mich., Nov. 28, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)



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SIGNAL FLASHERS
Make Driving Safer

Pneumatic Starters Best for Gas Turbines

Based on paper by

A. K. FORNEY

Bureau of Aeronautics, U.S.N.

THE Navy has flown practically every type of aircraft, with pneumatic starting systems. In large aircraft the complete system is usually installed in the aircraft and in some instances the gas turbine compressor is used to provide air for other than starting purposes. With carrier aircraft, however, agreement as to the best way of handling the system has been harder to reach. People primarily concerned with aircraft and their performance thought that as much of the system as practicable should be omitted from the craft and used as ground equipment. Those concerned principally with procurement and ground handling of equipment held that the complete system should be self-contained within the craft.

Present policy, reached after two years' debate, is to have the starter and control valve installed on the carrier aircraft, and consider the gas turbine compressor as special equipment, not included in aircraft weight empty, but packaged so that it can be carried at the option of operating personnel.

The conditions which make the optional self-contained system lightest for carrier aircraft may change, and if that time comes some other system may prove superior. The conditions are:

1. Fast starts (less than 10 sec from rest to engine idle rpm) are not required.
2. The optional self-contained policy proves operationally satisfactory.
3. Starting requirements do not increase substantially over the requirements of present engines.

The trend toward the so-called "twin-spool" engines indicates that starting requirements will not be substantially increased, but if they are,

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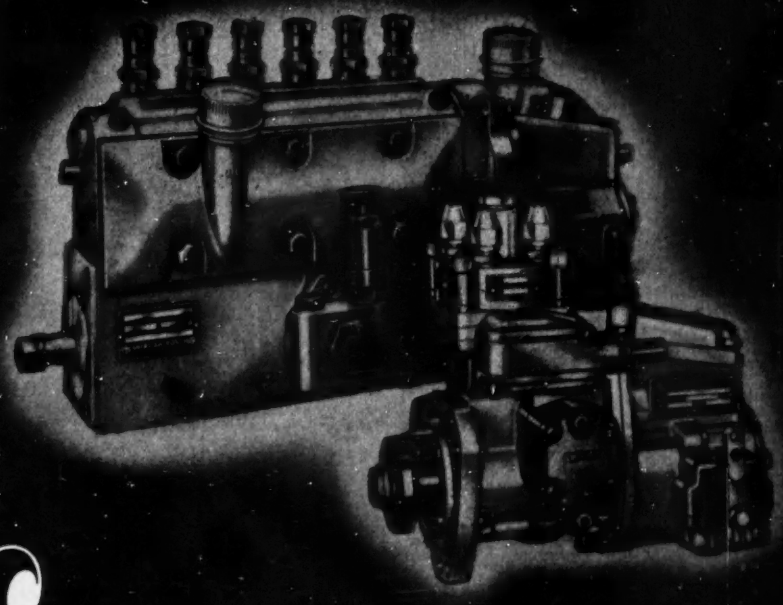

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the size of the compressor may become so large that it can no longer be carried as an external store. When that time comes, development of a system other than the pneumatic will be necessary.

The major problem in developing starter systems is not the starter, but the power source for the starter. Suitable starters of different types can be made available in reasonable sizes and weights for a wide range of power output. This is not true for power sources. Consequently, the system which offers the best solution for the power source problem will be the starting system used. (Paper, "Navy Development of Pneumatic Starting System for Gas Turbine Engines," was presented at SAE National Aeronautic Meeting, Los Angeles, Oct. 2, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Using Single Engine For All Lube Testing

Based on paper by

R. STANSFIELD
and
J. G. WITHERS
Anglo-Iranian Oil Co., Ltd.

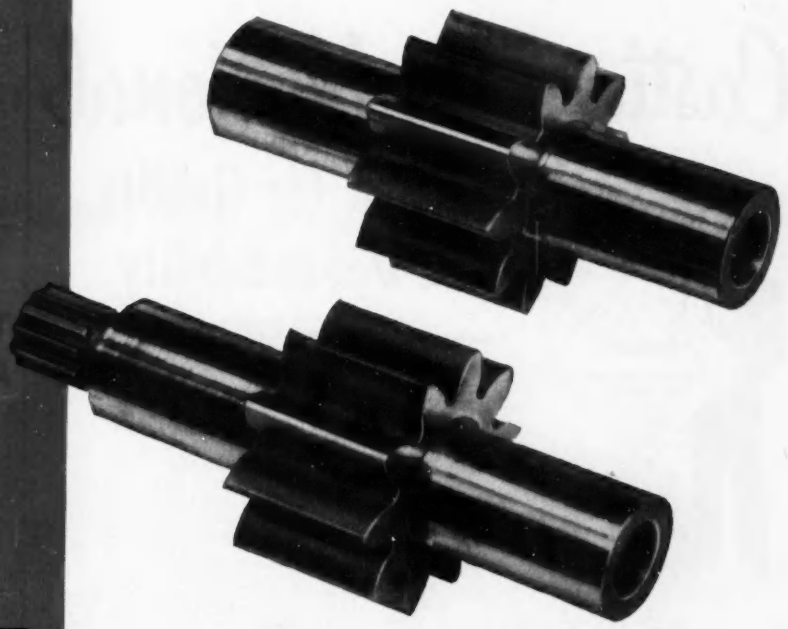
THERE are no irreconcilable differences between engines of different design in their reactions to lubricating oil quality. Even spark ignition and diesel engines do not differ fundamentally in this respect. Correlation of test results between them is probable provided the proper choice of operating variables is made.

The test engine must be so designed and constructed that it is possible to control all important temperatures appropriate to service conditions. Foremost in importance are the temperatures of the piston ring belt and the crankpin journal.

Combustion cleanliness in the test engine should be matched to service conditions. This may be difficult unless combustion conditions are good.

Since metals which catalyze oil breakdown reactions are present in service engines, it may be necessary to incorporate them in the lubricating oil test engine. Care must be exercised in the cleaning procedure of these metals in order to obtain reproducible results.

Probably the most important factor in correlating one engine test with another is the amount of fuel sulfur burned in relation to the total amount of new oil reaching the engine, with corrections for speed and piston diameter. This factor must be carefully matched and to do this may require increasing the sulphur content of the



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This SIMPLICITY OF DESIGN is important for these reasons!

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- ***less maintenance***
- ***less cost for overhaul***
- ***less weight . . . less noise***

Add *Pesco Simplicity of Design* to Pesco's exclusive, patented "Pressure Loading" principle, which results in volumetric efficiencies up to 97% and torque efficiencies up to 90%, and you have two important reasons why so many industrial and aircraft manufacturers have standardized on Pesco pumps.

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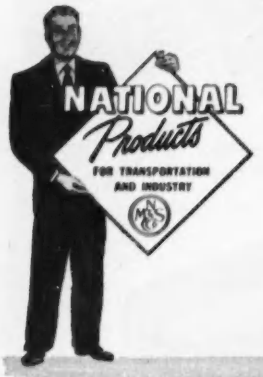

Products bearing these familiar trademarks have all established enviable reputations for quality and dependability. These manufacturers *continue* to procure castings by National—one of the Nation's largest founders.

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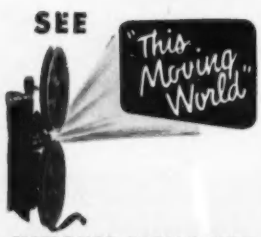

A 16mm Technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

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fuel used in the test engine to give the same test severity. (Paper, "The Correlation of Lubricating Oil Engine Test Procedures," was presented at SAE National Fuels and Lubricants Meeting, Tulsa, Nov. 6, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

Truck Deserves Care Accorded Machine Tool

Based on paper by

ROBERT CASS
The White Motor Co.

THE first and cardinal rule of good management practice is to see that the trucks purchased under specifications are actually employed within the limtis prescribed, assuming, of course, that the specifications are realistic. It is time to give up the practice of lip service with regard to what we propose to do with a piece of production machinery like a motor truck, and really see to it that it is treated and operated the way a machine tool would be operated in the factory producing that same truck. Strict observance of this principle is the way to get the lowest possible operating cost. (Paper "The Advancement of Motor Vehicle Management Particulars" was presented at SAE Texas Section, Houston, Sept. 12, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Proper Filtration Will Cut Engine Wear

Based on paper by

JULES P. KOVACS
Purolator Products, Inc.

LABORATORY tests with two pairs of engines equipped with different types of bypass filters made by the same manufacturer, have demonstrated that a filter with a low flow of oil through the filter medium shows a consistent increase of 15% in contaminant removal efficiency over the high flow type. At the same time, the results in terms of engine wear are contradictory, and thus give evidence that the degree of cleanliness in engine oil maintained by a filter is not all-important. Greater protection against wear can be had by filtering

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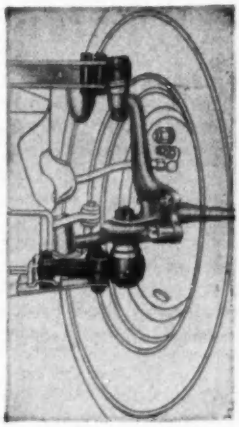
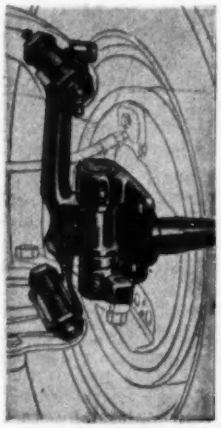
Thompson Front Suspension Ball Joints

"The car steers almost as easily while in motion as if it were equipped with power steering and easier at all speeds than most cars of comparable weight".

. . . from Mr. Clymer's Popular Mechanics report on the 1952 Lincoln, with whose engineers Thompson Steering experts worked in the development of its new front suspension ball joints.



Thompson Front Suspension Ball Joint



Standard King Pin Type Suspension

Lubrication points are reduced from approximately five to two fittings per side.

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- Reducing turning resistance for *much* easier steering.
- Creating new space for wider modern engine design.
- Cutting the manufacturers assembly line time.
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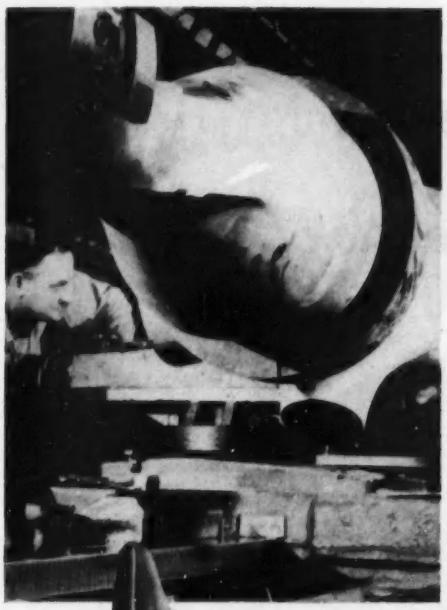
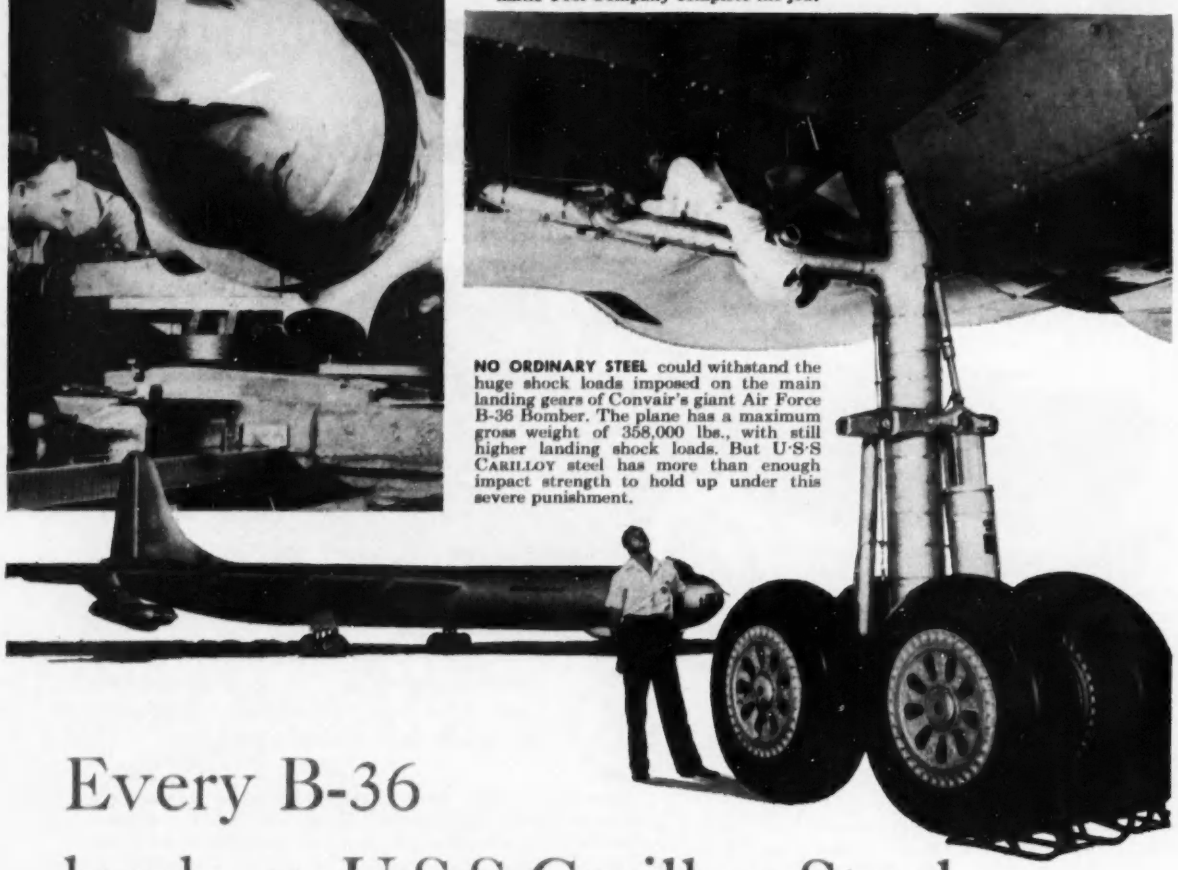


U·S·S CARILLOY electric-furnace aircraft quality steel meets every requirement for these vital parts. The precision machining and expert heat treatment they get at Cleveland Pneumatic Tool Company complete the job.



NO ORDINARY STEEL could withstand the huge shock loads imposed on the main landing gears of Convair's giant Air Force B-36 Bomber. The plane has a maximum gross weight of 358,000 lbs., with still higher landing shock loads. But U·S·S CARILLOY steel has more than enough impact strength to hold up under this severe punishment.

Every B-36 lands on U·S·S Carilloy Steel

WHEN 179 tons of B-36 thump down on a landing strip, tremendous stresses are built up in the structural parts of the landing gear. Only the highest quality in steel can handle this tough job, which is one of the most exacting in the aircraft industry.

All of the rugged main columns for these landing gears are made from U·S·S CARILLOY electric-furnace aircraft quality ingots. This high quality alloy steel provides the great strength and shock resistance demanded in the performance of the finished part. The main columns for these landing gears are forged. The original ingot, as shipped to the forger, weighs approximately 37,500 lbs. From it are produced two columns, each weighing about 1200 lbs. In other words, approximately 93% of the steel has been removed—with a mere 7% of the original ingot left to do this tremendous job. Obviously, only steel of the very best quality can meet such exacting requirements.

The same care and skill go into every ton of CARILLOY steel that *you* buy, whether it's a giant alloy ingot or a few tons of special steel. Our experienced metallurgists keep a close check on *every* heat of steel to make sure it has the strength, hardness, toughness and machinability that's needed.

If you have a special steel problem, let us know. We'll be glad to help you with it.

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UNITED STATES STEEL

a greater volume of oil to a lesser degree.

It is a known fact that engine wear is not due entirely to dust. However, the less contaminants are permitted within an engine, the greater will be its life. Where an air filter excludes practically all contaminants, it is obvious that upper cylinder wear will be diminished as will the top ring, second ring gap increase.

Controlled air flow properly filtered crankcase breathers can contribute substantially to engine operation. Filters for this application can be made which will give better than 99% efficiency, thereby decreasing contamination and giving a better control of air flow to reduce oxidation of oil in the crankcase. (Paper "Filtration for Internal Combustion Engines" was presented at SAE Metropolitan Section Meeting, New York, Sept. 18, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers).

U.S. Patent System In Need of Correction

Based on paper by

FRANCIS W. DAVIS
Consulting Engineer

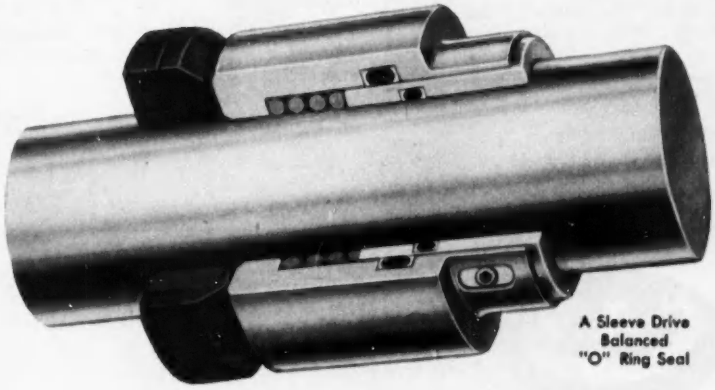
THROUGH protection it afforded inventors, the U.S. patent system has given them and their financial backers the incentive to risk their time, abilities, and capital in the creation and marketing of new and improved machines, products, and processes. But as against this we now have many evils that have crept into the system.

Some of the evils involve the high cost of securing patents, the delays in issuing of patents and the tremendous cost of litigation. The great majority of judges are not educated in mechanics, electricity, or chemistry, hence when patents are litigated a large percentage is held invalid or not infringed. Over 80% of the patents are so charged in the Circuit Court of Appeals. This encourages large manufacturers to "pirate" inventions.

The engineer should acquaint himself with patent procedure for as soon as he moves into industry he will have patent matters dumped into his lap. He will be asked to evaluate and report on scope, value, claims, infringement and many other details with which he may or may not be familiar. (Paper "Patent Procedures," was presented at SAE Student Branch at the College of the City of New York, New York City, Nov. 13, 1952. It is available in full in multilithographed form from SAE Special Publications Department. Price: 25¢ to members; 50¢ to nonmembers.)

Garlock "O"-Ring Seals

FOR ROTATING PUMP SHAFTS



A Sleeve Drive Balanced "O" Ring Seal

Simple in Design, Leakless in Operation

GARLOCK "O" Ring Mechanical Seals are made with a minimum of parts. This simplicity of design affords easy manufacturing adaptability of a Garlock "O" Ring Seal to withstand any liquid, whether mild, harmfully corrosive or extremely hazardous, on rotating pump shafts. The Garlock "O" Ring Balanced Seal will hold pressures up to and over 1000 p.s.i.

The "O" rings are available in "Teflon," Buna-N, Neoprene or Silicone. The metal parts contacting the liquid are available in any suitable metal.

On centrifugal pumps handling chemicals, petroleum products, edible liquids, pulp liquors, and many other liquids Garlock "O" Ring Mechanical Seals are giving outstanding service.

For positive sealing, easy installation and trouble-free service use Garlock "O" Ring Mechanical Seals on your rotating pump shafts. Write us about your sealing problems or contact your Garlock representative.

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RUBBER EXPANSION JOINTS

New Members Qualified

These applicants qualified for admission to the Society between May 10, 1953 and June 10, 1953. Grades of membership are: (M) Member; (A) Associate; (J) Junior; (SM) Service Member; (FM) Foreign Member.

Atlanta Group

Clarence C. Whiten (J).

Baltimore Section

Oscar Francis Klaburner (M).

Buffalo Section

Heinz Mueller (M).

Canadian Section

Joseph A. Atzberger (M), Alexander Murdock Marshall (A), William Edmond Moore (A).

Central Illinois Section

William C. Albrecht (M).

Chicago Section

Frank J. Butler (A), Carl Rex Canfield, Jr. (M), D. Wendell Fentress (M), Nicholas J. Hughes (J), Leopold P. Josephs (A), Harry T. Kessler (A), Donald J. Kullmann (J), Ellis R. Larson (A), Wayne W. Lehto (M), Ernest J. Mehochko (A), Paul B. Miller (A), Leonard C. Nelson (M), J. N. North (A), Warren K. North (J), Richard V. Nutt (J), Wynn E. Petersen (A), P. L. Reynolds (A).

Cincinnati Section

Samuel A. Dean (A).

Cleveland Section

Peter A. Asseff (M), Joseph B. Boynton (A), Gerald D. Griffin (J), John D. Hanks (M), Robert H. Josephson (M), Anthony F. Kaminskas (M), John V. Koteles (J), Lloyd E. Sump (M).

Dayton Section

C. M. Allen (M), Helge M. Evensen (J).

Detroit Section

Robert B. Alexander (M), Douglas L. Armstrong (M), Peter Chatfield Ball (J), Irving Noble Bishop (J), Harry A. Bolenski (M), Arthur S. Brown (M), James Whitman Buckley (M), Robert H. Carpenter (M), John Gerald Champine (J), R. Lawrence Crosier (J), Stanley Dacko (J), John Dankovich, Jr. (M), James E. DeRemer (M), Robert L. Erwin (M), Maurice E. Fordyce (J), Robert R. Furney (M), Robert E. Gleason (J), John Woodward Groomes (J), Richard B. Harper (M), Kenneth Clifford Huhta (J), James C. Kaufeld (J), Robert E. Kraemer (M), Jay Winfield Kreusser (J), Anthony Kushigian (J), Douglas Sidney Lee (A), O. Martens (M), John F. McCarthy (A), Gene H. McDonald (J), Bert T. Olson (M), Clayton J. Pajot (M), Andrew J. Pepper (M), Charles R. Petoskey (A), Richard F. Reichmuth (M), Jorma O. Sarto (M), John F. Scarpelli (A), Donald James Schwalm (J), Joseph W. Schwartz (M), William D. Shanks (M), Robert H. Stridiron (M), Steve J. Trukalo (M), Gaylord E. Underwood (J), William Arthur Weidman (J), Norman C. Wilson (M), Robert W. Zander (A).

Hawaii Section

Fred K. Cordes (A), Robert Louis Linder (A).

Indiana Section

Paul B. Budai, Jr. (J), Charles L.

Continued on Page 128

C.A.V.
The world's largest manufacturers of Fuel Injection Equipment
for diesel engines
Depots and Service Agents in over 100 countries
C.A.V. DIVISION OF LUCAS ELECTRICAL SERVICES INC., 653, TENTH AVENUE, NEW YORK 19, N.Y.
Sales Office: 14820 DETROIT AVENUE, CLEVELAND 7, OHIO.
C.A.V.
Fuel Injection and Electrical Equipment

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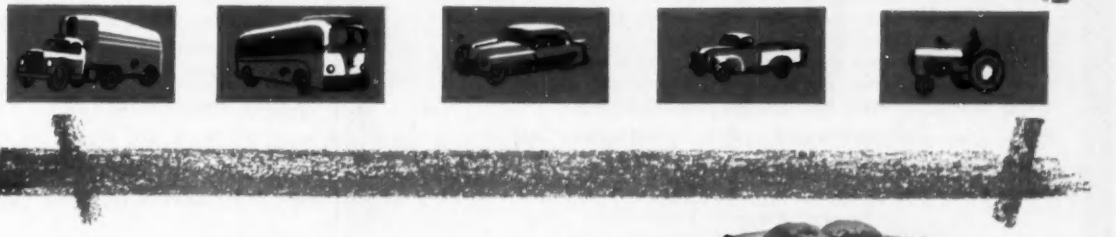

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New Members Qualified

continued

Cutter (J), John M. Vaught (J).

Kansas City Section

Joseph Lynn Forinash (M), William Alfred Lane (A), Donald P. Workman (M).

Metropolitan Section

Robert W. Brattvet (M), Laurence Clements (J), Sidney Nathan Dexter (M), Raymond M. Ferris (J), John A. Mowbray (M), Helmer Peterson (M), Gerald S. Rothman (M), James J. Scott (M), George Charles Skillman, Jr. (J), Cyrus Rowlett Smith (M).

Mid-Michigan Section

Roy L. Bowers (M), Homer Russell Hastings (M), Ralph M. Howes (M), Albert E. Katzer (J), Lyman M. Lamoreaux (J), William Blair Thompson (J).

Milwaukee Section

George F. Bastian (A), William Francis Elliott (M), Howard E. Galineau (M), Edward A. Kubicek (J), Robert L. Trapp (J), James E. Vetter (J), Henry T. Wenten (M).

Montreal Section

B. Gordon Glass (M), David Greenhill (M), Leslie H. Kottmeier (M), Roland Lesperance (M).

New England Section

Vance Phillips (A).

Northern California Section

Roland F. Bergstrom (M), Robert E. Blank (A), Frank T. Kataoka (A), John F. Koehnle (M), Robert W. Kraft (M).

Philadelphia Section

Christian W. Goll (M), Bennett D. Jones (M), Arthur Clinton Miller (J), John R. Pichtelberger (J), Earl A. Smith, Jr. (M).

Pittsburgh Section

H. G. Cranston (M).

St. Louis Section

Paul J. Kleine (J), F. E. Myers (M).

Salt Lake Group

Ray O. Girton (M).

San Diego Section

Robert Ashley (M).

Southern California Section

Julius Joseph Davis (M), R. R. Heideman (A), David G. Lewis (M), Karl Lindberg (M), Albert Bracewell Seed (J).

Syracuse Section

Fred J. Michel (M).

Texas Section

Edward J. Sears (M), Robert A. Stevens (J), George C. Taska (A).

Twin City Section

Jesse R. Gardner (A), Louis J. Pauly (M).

Washington Section

Robert Burkhardt (A), James Thomas DiPiazza (J), John J. McKee (A), Michael A. Schmidt (J).

Western Michigan Section

Albert A. Carlson (A), John Margil Simonetti (M).

Outside Section Territory

Millard Bachelder (J), George Bohn,

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Mr. R. A. O'Brien

Mechanics Research Department

American Machine & Foundry Co.

188 West Randolph Street Chicago 1, Ill.

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KEARFOTT COMPONENTS INCLUDE:
Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

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West Coast Office: 26 N. Santa Anita Ave., Pasadena, Calif.
A General Precision Equipment Corporation Subsidiary

New Members Qualified

continued

Jr. (A), Vincent A. Butler (J), Joseph H. Dolan (M), David R. Ferris (M), Alfred Bruce Sauer (J).

Foreign

Yoshie Akiba (M), Japan; Lucien Bignon (M), France; John Bell Christian (M), British West Indies; Sven Ekelund (M), Sweden; Goran Moberg (M), Finland; Ivor Richards (M), England.

Applications Received

The applications for membership received between May 10, 1953 and June 10, 1953 are listed below.

Atlanta Group

Charles Briscoe Sanford, Jr.

Baltimore Section

James Clinton Hussong, Leroy T. Wallick.

British Columbia Section

G. L. Creighton.

Buffalo Section

Robert L. Barager, Peter M. Byam, Merle S. Day, Willard O. Emmons, Kenneth C. Engel, Samuel Scappettuolo.

Canadian Section

Wallace J. Kribs, James C. Macdonald, Maurice Hampton Satchell, George McCaul Findlay Smith, Frank Stevenson.

Central Illinois Section

Francis X. Hufeld, William C. Pickering, Jr., John J. Steuby.

Chicago Section

Robert W. Allen, Johannes Henri Boon, Michael Chucta, M. L. Davis, D. J. Gardner, M. P. Kleinholz, Jack Pershing Stanton.

Cincinnati Section

Harry J. Kent.

Cleveland Section

L. J. Bechhold, Delmar E. Benjamin, Robert C. Brigleb, William Edward Buescher, Norman K. Conrad, Raymond R. Decker, Irwin T. Harris, Lyle G. Higgins, Milan A. Kontosh, Matthew Charles Kuepfer, II, Clyde R. Lang, R. E. Lee, James W. McConaghy, Thomas Howard Wiggins, Taylor Wyckoff, D. C. Aldrich.

Applications Received

continued

Colorado Group

Alan Frederick Schmidt, Richard Elliott Wainerdi.

Dayton Section

Kenneth R. Durst, Capt. Bob Korf, Salvatore M. Marco.

Detroit Section

William G. Agnew, Dogan H. Arthur, Charles E. Barby, Paul A. Bennett, Constant L. Bouchard, William J. Burke, Bernard A. Chapman, Robert West Connor, John Zachary DeLorean, John Eric Desmond, John A. Dobb, George A. Dow, Arthur R. Dulzo, George R. Eckhoff, Joseph Lee Gross, Norman Hagood, Joseph M. Hodess, Frank W. Hudson, Donald H. Huey, Fred Jubera, William Martin Kelly, Max S. Koga, Donald J. LaBelle, Gordon J. Lawton, R. Wayne Macy, Stewart E. Norwood, Harold F. Pierce, John F. Sieberth, Henry M. Stahl, John E. Stepleton, Walter R. Swanson, Louis A. Welt, Daniel Chieger, Edward Daniel Klomp.

Hawaii Section

Joseph Melville Ireton, Iwao Motonaga, Iwao Yonemitsu.

Indiana Section

George A. Campbell, James Richard Hunter, Donald D. Kriplen, Thomas Osorio Newby.

Kansas City Section

Evan D. Bolin, Isadore Levitch.

Metropolitan Section

Paul A. Binda, Donal L. Botway, Jack M. Cherne, Gregory Jamieson Comstock, Charles Eitzen, Kenneth H. Fox, Maxwell H. Giden, Edward G. Goldstone, Eugene C. Lang, John P. Lauri, Donald S. McDowell, John T. Mealy, Samuel R. Murray, Walter D. Myers, Jr., Fred Carroll Runfola, T. Stanford Tutwiler, Aaron Vanglish, Joseph P. Yakal.

Mid-Continent Section

Charles Edwin Davis.

Milwaukee Section

Charles Featherly, Emil J. Granitz, Gerald E. Gutzmann, Leo Hopfensperger, Lloyd Paul Post, Paul Host Schmitt, Gilbert Fred Weissert, William R. Witzel.

Mid-Michigan Section

Robert J. Breeden, Arthur W. Corey, Fred M. Ison, Frank V. Klco, Kenneth F. Lehman, John R. Thomas.

Mohawk-Hudson Group

Patrick J. Bruno, Reginald D. Hartwell, James G. Kiernan, Edgar J. Lanious, Jr., James C. Nelson, Jr.

Montreal Section

J. L. André Bachand, Wesley E. Ball, Frank H. Rousseau.

New England Section

Paul A. Hood.

Northern California Section

Jack H. Herron, Arthur B. Pennimman, Alexander M. Plunkett.

Northwest Section

Raymond Edward Couture.

Oregon Section

Robert J. Hagelberger, James R. Montgomery, Gerald A. Schuler, James M. Springer, Stanley E. Watt, Wallace H. Yost.

Philadelphia Section

Ralph Orville Brunt, Lawrence I.

Continued on Page 132

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. . . stands ready to help you with your Rubber Engineering Problems and Development.

Tyer experience and skill has helped many firms in the following fields—

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Medical • Business Machines
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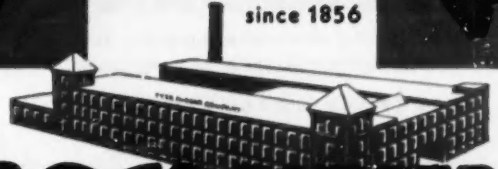

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St. Marys, Pa.

BRUSHES FOR ALL ROTATING ELECTRICAL EQUIPMENT
BEARING MATERIALS • BRAZING FURNACE BOATS
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RAIL BONDING MOLDS • RESISTANCE WELDING AND BRAZING TIPS • SEAL RINGS
TROLLEY AND PANTOGRAPH SHOES . . . *and dozens of carbon-graphite specialties*

Applications Received

continued

Chasen, Charles A. Moyer, Seymour Wolf Shapiro, Ray Tieger.

Pittsburgh Section

Colin Irving Bradford, Charles W. Cable, Fulton R. Magill, Matthew A. Opeka, James F. Wagner, William C. Weltman, Jr., David T. Rogers.

St. Louis Section

Howard Feldman.

San Diego Section

Henry Berlinghof, Jr., Herman L. Braasch, Floyd Cox, Robert Arthur Cox, W. G. Hubbell, Jean R. Kohl, Kenneth K. Krull, Lawrence M. Limbach, John Ward Maloney, Angelo A. Mattei, Harold A. Welch.

Southern California Section

Gerald A. Burmeister, George Rosel DeLay, Alex Gonzalez, Robert Lawrence McKinnon, Milton L. Patrick, Gordon Edward Saxon, Arnold E. Thompson, John A. Wagner.

Southern New England Section

Richard F. Barbian, Robert James Black.

Spokane-Intermountain Section

Frederick Fleming, Reuben A. Pister.

Texas Section

James J. Gilchrist, Laurel E. Goodloe, Richmond W. Hathaway, Daniel H. Olsson, Harris Saunders, Jr., Leif A. Zars.

Texas Gulf Coast Section

H. Joseph Chase.

Twin City Section

David H. Gruver.

Washington Section

Norman B. Christie, A. Sidney Hanson, Jr., J. Melvin Miller, Wesley E. Schwieder.

Western Michigan Section

C. Alkema, Jr., Gerald W. Brininstool, Alfonse A. DeMuro.

Outside Section Territory

Irving M. Bant, Bruce Melvin Bearden, Grammer Grant Edwards, Robert J. Felthaus, R. O. M. Grutle, George G. Love, B. H. McMillan, Lewis A. Montgomery, Jr., Albert Theodore Reiff, Jr., Robert Kyeu-Wo Suez.

Foreign

Paul Ivanyi, Brazil; Walter Keller, Switzerland; Thomas Bruce McSweeney, New Zealand; Marco Pierre, France; Richard Stent, New Zealand; James E. C. Van Luppen, Belgium.

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Whether you're designing the clutch for a twenty ton prime mover or the brake for a fractional horsepower motor, it will pay you to specify Velvetouch. Because Velvetouch is built for extra heavy duty service!

Unlike ordinary friction material, Velvetouch is made from powdered metals, compressed and fused to a strong steel backing plate. As a result, it runs cooler, lasts longer . . . can't deteriorate or burn like asbestos. And by changing the metal mixture, the friction characteristics of Velvetouch can be altered to meet specific clutch and brake requirements.

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* DALLAS—3407 Main Street, Dallas 1, Texas

** DETROIT—16622 James Couzens Highway, Detroit 21, Mich.

* LOS ANGELES—1110 South Hope St., Los Angeles 15, Cal.

* PHILADELPHIA—1545 West Bellfield Ave., Philadelphia 41, Pa.

* PORTLAND—636 N. W. 16th Ave., Portland 9, Oregon

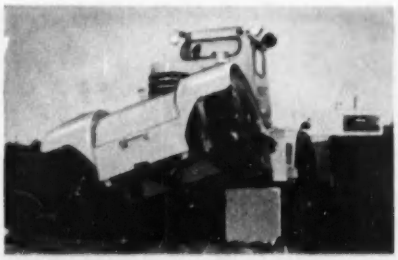
* SAN FRANCISCO—424 Bryant Street, San Francisco 7, Calif.

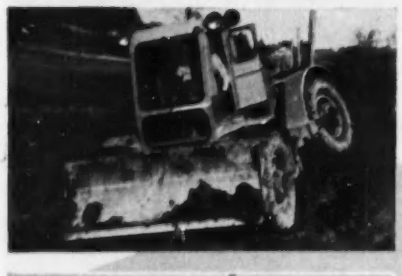
* TORONTO, ONTARIO—The S. K. Wellman Co. of Canada, Ltd., 2839 Dufferin St.

** WASHINGTON—1101 Vermont Ave., N. W., Washington 5, D. C.

** EXPORT DEPARTMENT—8 South Michigan Ave., Chicago 3, Illinois

* SALES OFFICE AND WAREHOUSE ** SALES OFFICE





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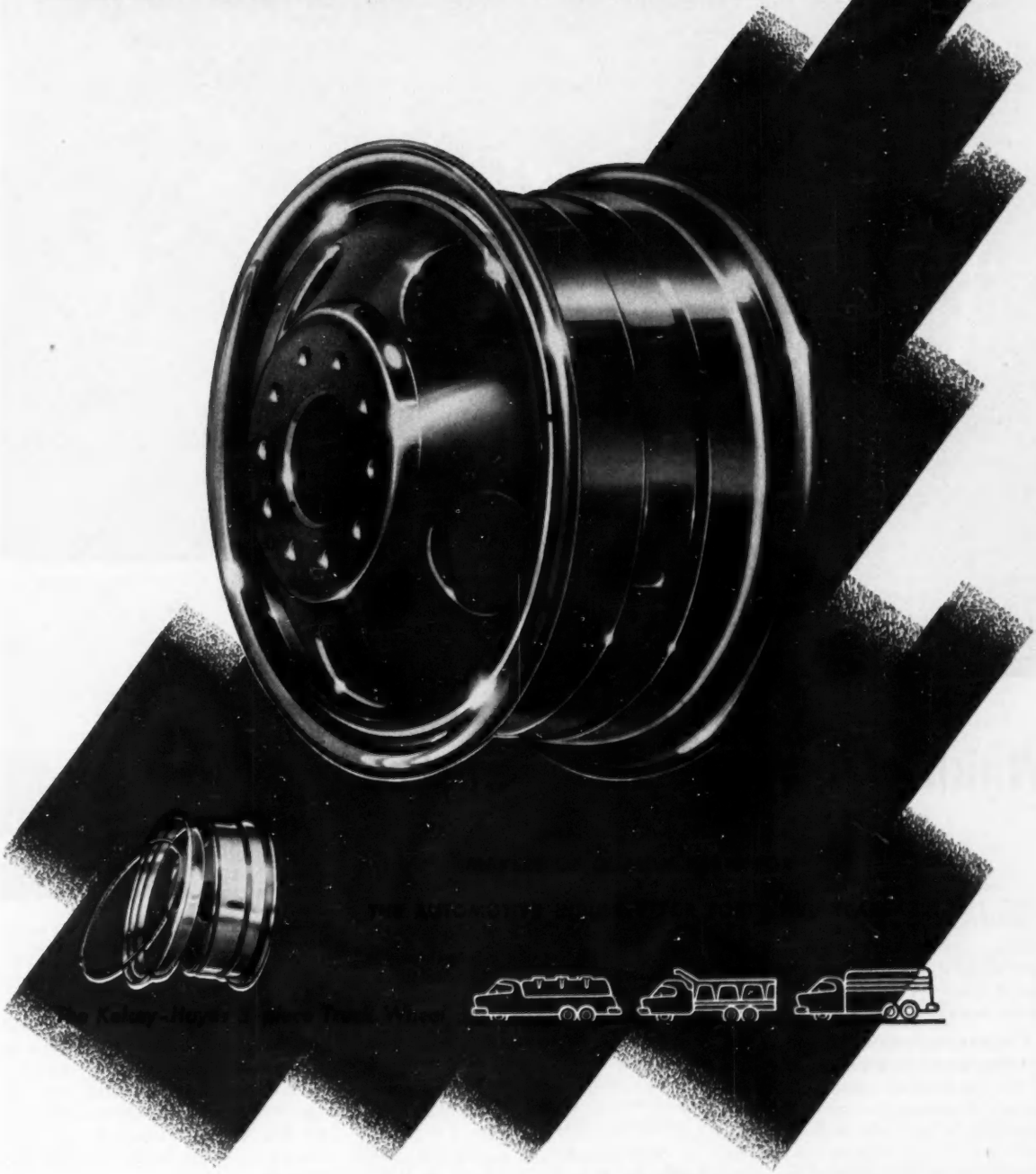

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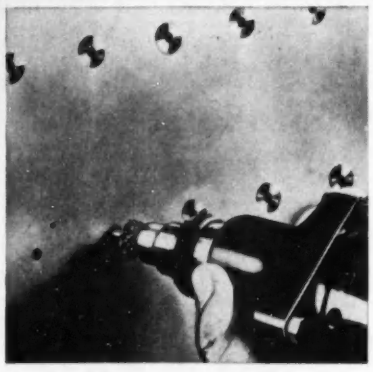
OSBORN



Osborn wire brush, automatically located, removes zinc chromate from around rivet holes in aircraft production.

Which of these versatile brushes will cut your costs?

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The small Osborn brush shown in operation enables one man to do the work of seven men. Output per man went up 700% in this aircraft application of removing zinc chromate priming from around rivet holes in wings and fuselages. Formerly this job was done by hand with small sandpaper discs.

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NEW ENGINES REQUIRE BETTER GASKETS

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McCord originated and manufactured the first cylinder head gaskets in 1908, and McCord research and development provided consistent improvement in gasket design and construction throughout the ensuing years. With the advent of the new higher compression overhead valve type motors, McCord again led the industry in the development of the embossed steel type gasket now used by leading car and truck makers for equipment.

The design of the embossing is engineered to provide a perfect seal at the combustion chamber and water outlets.

Because of the design and formation of the embossing, the flow of the metal under compression is even, providing a better gasket seal.

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The McCord all metal embossed gasket provides an even and uninterrupted flow of heat between cylinder head and motor block.

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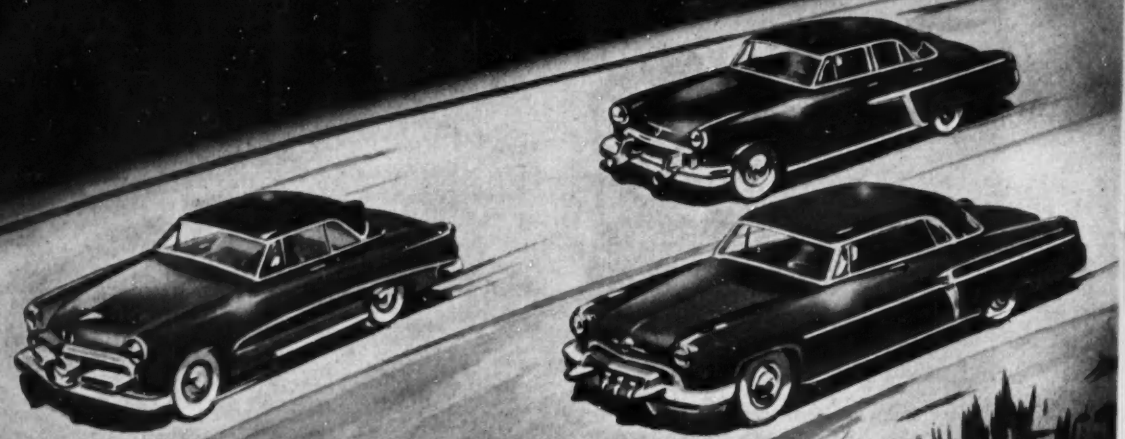
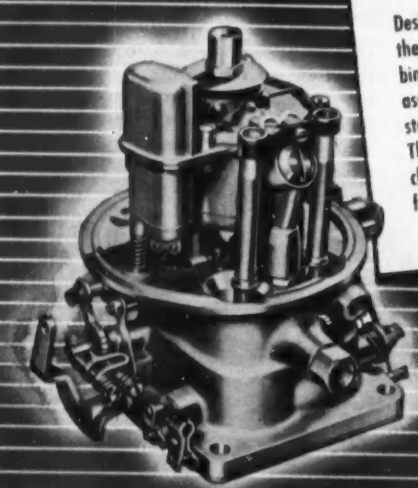
IMPORTANT ENGINEERING ACHIEVEMENT:

Carburetor Pressures Coordinate Fuel Flow And Timing

WHERE **HOLLEY CARBURETORS**
ARE USED WITH **HOLLEY DISTRIBUTORS**





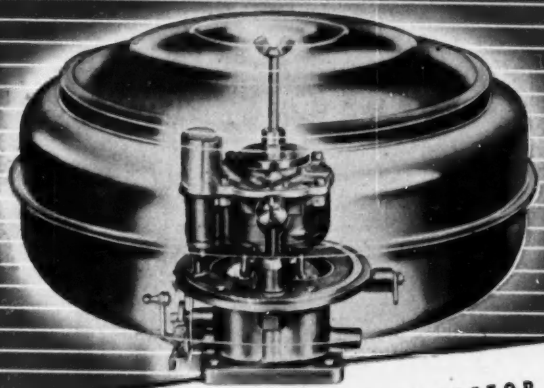
CENTRI-QUAD CARBURETOR

Designed to add horsepower to present day engines, the Holley Centri-Quad is the only carburetor to combine four barrels into one carburetor with one float assembly. The concentric design prevents loading or starving during sharp turns and fast stops and starts. The Centri-Quad is designed for the same basic air-cleaner installation as used on the Centri-Flo. Calibrated for engines of 150 to 225 horsepower.

WITH

HEAVY DUTY PRESSURE DISTRIBUTOR

Designed for installation on maximum horsepower engines, the heavy duty pressure distributor meters spark in exact relation to power requirements and fuel flow because it operates from pressures which exist within the carburetor.



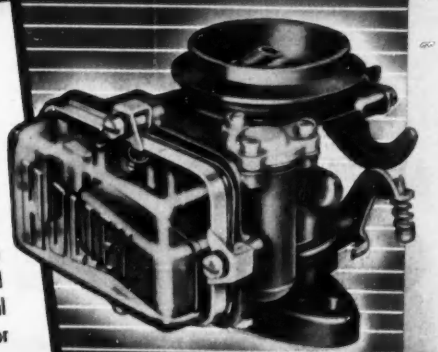
CENTRI·FLO CARBURETOR

This true concentric carburetor is designed with all important metering parts at the center line of the fuel bowl. The Centri·Flo assures smooth, uninterrupted engine performance during fast stops and starts and sharp turns. The unique carburetor and air-cleaner combination allows lower hood lines—meets the modern styling trends. Calibrated for engines of 110 to 180 horsepower.

OR

VISI·FLO CARBURETOR

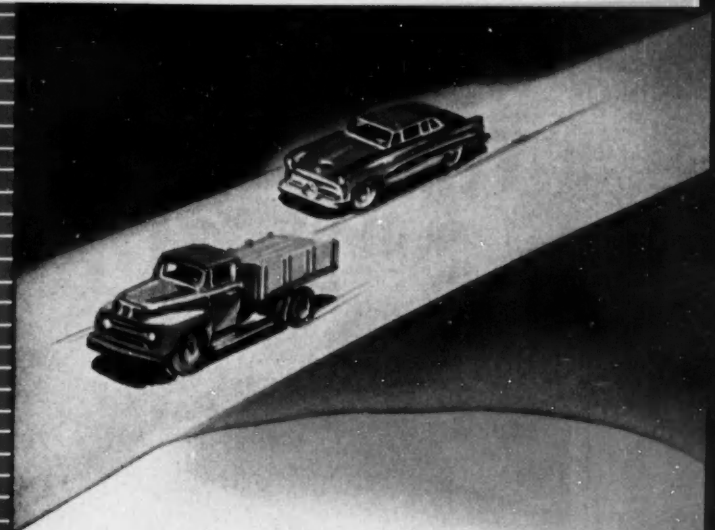
The clear glass fuel bowl and the replaceable metering unit features of the Visi·Flo have revolutionized carburetor service. This compact carburetor—only four inches high—can be used where limited overhead space ordinarily requires special manifold design. Calibrated for 80 to 120 horsepower.



WITH

PRESSURE DISTRIBUTOR

Combined with either the Visi·Flo or Centri·Flo carburetor, the Holley pressure distributor provides quicker, smoother performance and greater fuel economy. Holley pressure distributors are the only distributors now available that eliminate the need for a centrifugal advance mechanism.



Combining fuel and ignition controls is one of the newest "new thoughts" originated by Holley to increase standards of engine efficiency and performance. Each of the carburetors shown on these pages is designed to provide the best performance when used with a Holley pressure distributor.

These original equipment products have been adopted by some of the most famous names in the passenger car and truck fields. There is a combination available for nearly every horsepower rating now used in the automotive industry.

ARE YOU WONDERING . . .

How to do a good job of fuel metering better? Let Holley engineers listen, test, design, and recommend.

HOLLEY

Carburetor Co.

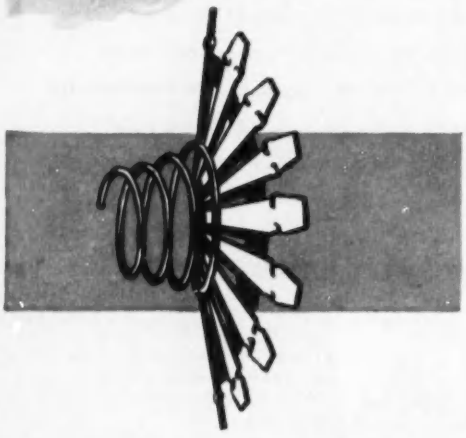
DETROIT 4, MICHIGAN

FOR MORE THAN HALF A CENTURY—
ORIGINAL EQUIPMENT MANUFACTURERS
FOR THE AUTOMOTIVE INDUSTRY

The SOFT Acting Clutch with the SURE GRIP!

...Just like a
Hand of Steel in a Velvet Glove

LIPE
MULTI-LEVER
CLUTCH



The hand of steel in the Lipe Clutch has 20 fingers that equalize the pressure of a single spring—assuring softer engagement and a positive grip.

Lipe's soft engagement, positive grip Multi-Lever Clutch never needs babying. It engages smoothly —without grab, shock or jerk. All parts of the pressure plate touch at the *same instant* with the *same* pressure. No cocking—no point of high slippage and spot burning.

Result: *More mileage between tear-downs.*

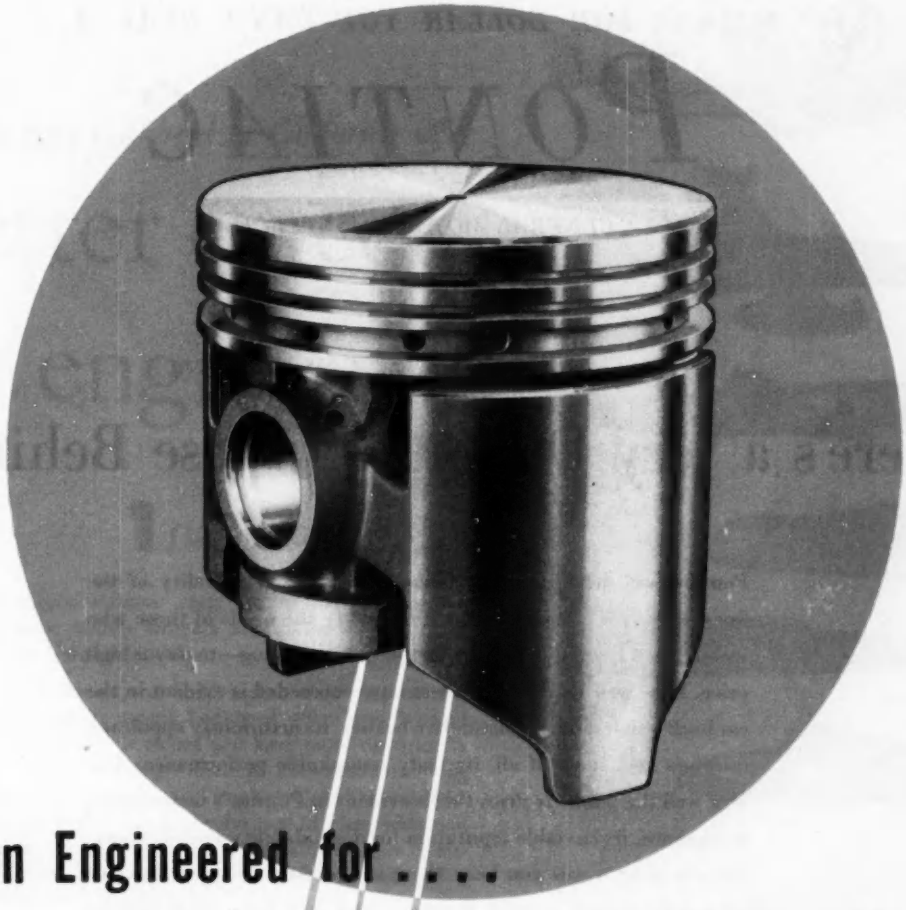
Write for Service Manual and complete data on genuine Lipe parts—stocked in principal cities.

LIPE ROLLWAY

Lipe-ROLLWAY CORPORATION

Manufacturers of Automotive Clutches and Machine Tools

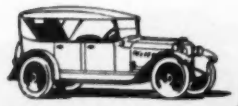
Syracuse 1, N. Y.



Precision Engineered for . . . .

SMOOTH FLOWING POWER • HIGH OPERATING EFFICIENCY • MAXIMUM STRENGTH

PERMITE PISTONS



Over 30 Years of Service to the Automotive Industry 1921 to 1953

PERMITE

YEAR after year in leading makes of cars, trucks and buses, Permite Pistons prove their quality and stamina. Permite design and production engineers gladly work with automotive manufacturers on problems concerning their requirements for pistons, valves and other engine parts.

ALUMINUM INDUSTRIES, Inc. . . . Cincinnati 25, Ohio

Detroit: 809 New Center Building New York: 9 Rockefeller Plaza

Chicago: 64 E. Jackson Boulevard

ALUMINUM PERMANENT MOLD AND SAND CASTINGS . . . HARDENED, GROUND AND FORGED STEEL PARTS

DOLLAR FOR DOLLAR YOU CAN'T BEAT A

PONTIAC

A GENERAL MOTORS MASTERPIECE

There's a Very Definite Purpose Behind It!

Pontiac was deliberately designed to provide the quality of the finest cars at a price low enough to satisfy the needs of those who seek a fine automobile but are unable—or unwilling—to pay a high price. How well Pontiac engineers have succeeded is evident in the car itself—in its size, its distinctive beauty, its luxuriously appointed interiors and, most of all, its truly remarkable performance. And how well the public realizes this is evident in Pontiac's unsurpassed acceptance, its enviable reputation for dependability and economy, and the good words you hear about it everywhere. If you haven't personally driven a 1953 Pontiac, why not visit your nearest dealer and do so at your first opportunity? You'll find it very hard to believe that so fine a car can be priced so low!

PONTIAC MOTOR DIVISION OF GENERAL MOTORS CORPORATION

Why does Lockheed in California offer

better careers for engineers?

1 *Diversified Production*

Fighters, bombers, trainers, cargo transports, radar search planes and huge luxury airliners are rolling off Lockheed assembly lines. Twelve models are in production.

This capacity to design and build such a wide range of aircraft is important. It means Lockheed offers you broader scope for your ability. It means you have more opportunity for fresh, creative thinking – because Lockheed's thinking covers *all* phases of aeronautical engineering. It means your future is not chained to any particular type of plane – because Lockheed is known for leadership in virtually *all* types of aircraft. It also is one of the reasons Lockheed has an unequalled record of production stability, year after year.

2 *Diversified Development Projects*

The most diversified development program in Lockheed's history is under way – and it is still growing. It means more and better career engineering opportunities for you – now and in the future. It means your career can grow with a company that is growing on *all* aviation fronts.

3 *Diversified Living*

You work better in Lockheed's atmosphere of progressive thinking – and you live better in Southern California. You enjoy life to the full in a climate beyond compare, in an area unequalled for opportunities for recreation and outdoor living.

Immediate openings for:

- Aerodynamicists
- Airplane Specifications Engineers
- Ballistics Engineers
- Dynamicists
- Flight Test Engineers "B"
- Flutter and Vibration Engineers
- Instrumentation Engineers
- Research Engineers
- Scientists for systems analysis and military operations research
- Servomechanism Engineers
- Stress Engineers
- Structures Engineers
- Thermodynamicists
- Weight Engineers

Lockheed

AIRCRAFT CORPORATION

BURBANK, CALIFORNIA

Send today for illustrated brochure describing life and work at Lockheed in Southern California. Use this handy coupon.

Mr. Gene Des Laurier, Employment Mgr., Dept. SAE-7

Lockheed Aircraft Corporation Burbank, California

Please send me your brochure describing life and work at Lockheed.

My Name

My Street Address

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My Field of Engineering

LORD MOUNTINGS *Protect Vital Parts* *on* EVERY TYPE of AIRCRAFT

Choice of the Leading Builders of Aircraft-

FOR more than a quarter century Lord Headquarters for Vibration Control have designed and manufactured bonded-rubber mountings to protect vital aircraft components from vibration and shock . . . to improve the overall operation of aircraft . . . to contribute to passenger and crew comfort. Among the many well known Lord Mountings in the Aviation Industry are (1) Dynafocal Engine Suspensions (2) Instrument Panel Mountings (3) Antennae and Electronic Equipment Mountings (4) Cowl Mountings (5) Actuator Attachment Mountings. There are many others.

We invite you to take advantage of Lord experience in vibration control . . . Ask about maintenance cost savings effected by Lord Core Renewal Service on Dynafocal Suspensions.

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413 Fidelity Union Life Building

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LORD MANUFACTURING COMPANY • ERIE, PA.

LORD — BONDED RUBBER

Headquarters for **VIBRATION CONTROL**

Add Greater Strength to Lighter Weight...

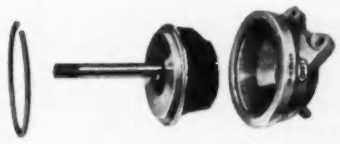
and take your PROFIT IN PAYLOAD!

The New LORD MR-36M DYNAFOCAL ENGINE MOUNTING

FOR R-2800 C ENGINES

THIS new Lord Dynafocal Mounting is interchangeable as to vibration characteristics and physical dimensions with any mounting now in use on Convair 240 and 340, Douglas DC 6 Series, Martin 404 and Military Aircraft using R-2800c engines. The Lord MR36M is stronger than any mounting of previous design. Its light weight saves up to 16 pounds per engine, depending on the type of mounting system now used. This new Lord Dynafocal can replace your present heavy mountings without any rework whatever.

The Lord MR36M Mounting is approved by CAA, USAF and Navy Bureau of Aeronautics. The reduced weight on 2 and 4 engine aircraft enables you to realize an immediate profit in additional payload. For complete details you are invited to write direct or refer to the field offices listed below.



EXPLODED VIEW

Ask about maintenance cost savings you can enjoy by using Lord Core Renewal Service on Dynafocal Suspensions.

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PHILADELPHIA 7, PENNSYLVANIA 725 Widener Building
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LORD MANUFACTURING COMPANY • ERIE, PA.

See Our Exhibit
NATIONAL AIRCRAFT SHOW
Dayton Municipal Airport, Vandalia, Ohio
Sept. 5-6-7

LORD BONDED RUBBER

Headquarters for VIBRATION CONTROL

New DELCO-REMY Coil and Resistor for 12-Volt Systems

Meet New High-Compression Ignition Requirements!

This new Delco-Remy coil and resistor team—like other elements in the 12-volt ignition system for '53 GM cars—is the result of modern, top-level engineering practice. It is an important reason why ignition performance in the new high-compression V-8 engines exceeds every requirement by a wide margin.

The new coil, although the same size as Delco-Remy's standard 6-volt unit, delivers 50% more energy to the spark plugs at low speeds—100% more energy at high speeds. This remarkable performance results from higher inductance primary and secondary windings made possible by the 12-volt electrical system.

An integral part of the new coil design is the external series resistor. Wound with constant-temperature-coefficient wire, it increases coil efficiency by cutting internal heat by half—lengthens contact point life by controlling primary current at low temperatures.

Here, then, is another fine example of the balanced performance of matched units for which Delco-Remy is so well-known—of precision in engineering design which leaves no room for substitution.

DELCO-REMY

Division, General Motors Corporation
Anderson, Indiana

AUTOMOTIVE, TRACTOR AND MARINE ELECTRICAL EQUIPMENT

1903 1953
FIRST FIFTY YEARS
CLARK EQUIPMENT

CLARK

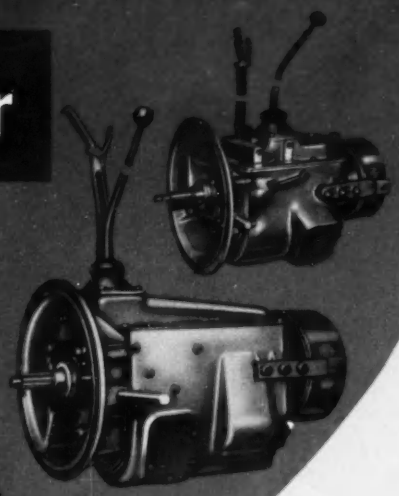
If ever there was a project that called for ignoring common practice and getting back to actual requirements, it's the development of a drive mechanism for a modern commercial vehicle—automotive, agricultural or industrial . . . Consult Clark—about a driving unit designed to meet the functional operating needs of your particular machine. . . . Clark engineering has always pioneered, since the first Clark axle in 1916, and still does—which is why leading industries like to "Work with Clark."

Turn and see reverse side for more about CLARK products

CLARK EQUIPMENT COMPANY, Buchanan, Michigan

Other Plants: BATTLE CREEK AND JACKSON, MICHIGAN

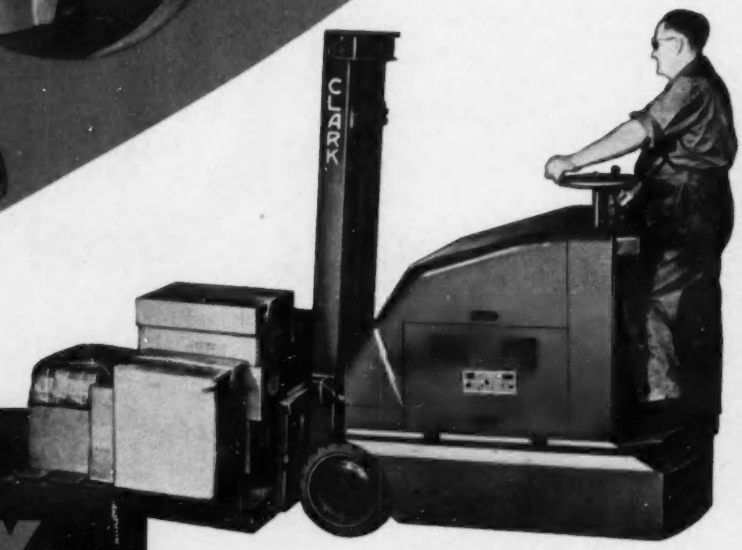
CLARK'S Split-Pin Synchronizer



The "Split-Pin" Synchronizers are now in these two Clark transmissions now available—what is not new is the Clark enthusiasm for engineering research, combined with the practical knowledge of industry's needs.

It is this traditional Clark attitude toward design that will continue to produce a full line of standard transmissions, and continue to tackle and solve special problems involving unusual transmission requirements . . . for trucks, busses, farm tractors, industrial trucks, and road building machines.

Write for Products Booklet.



Meet CLARK'S New STOWAY

WHY PAY FOR costly repairs and down-time on equipment that's supposed to save money? Here's a brand new stand up truck, built for (and by) people who know that *quality* machines always pay off in longer life, greater production. 2000-lb. capacity, electric-battery power, 60-inch turning radius and 360-degree steering—the STOWAY is the *quality* truck for close-quarter work.

For freight terminals and warehouses—for narrow aisles, congested floor space, operations where the driver is constantly on-and-off to sort out shipments and make up cargoes—the STOWAY is job-engineered to fit the handling pattern. Take the headaches out of L.C.L. handling, the bottlenecks out of cluttered terminals and warehouses—with Clark's new STOWAY.

Write for Material Handling News.

1903 1953
CLARK EQUIPMENT

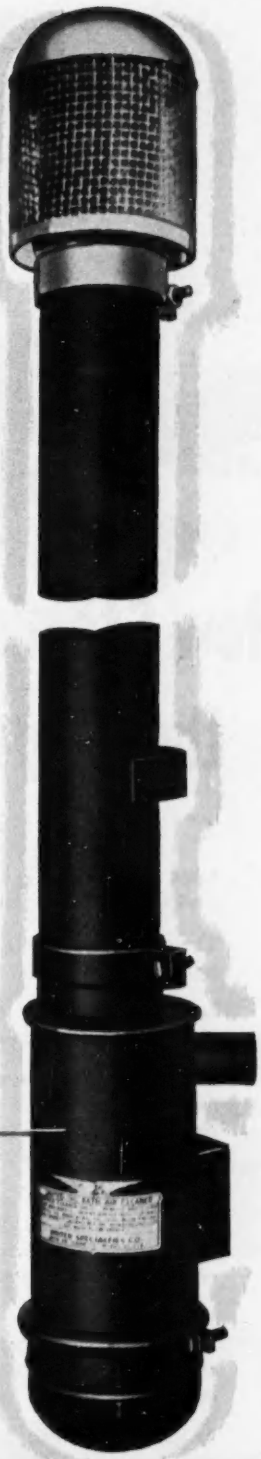
CLARK EQUIPMENT *Products* — TRANSMISSIONS • AXLE HOUSINGS • GEARS and FORGINGS • TRACTOR UNITS • FORK TRUCKS and TOWING TRACTORS • FRONT and REAR AXLES for TRUCKS and BUSSES

CLARK EQUIPMENT COMPANY
BUCHANAN, MICHIGAN

Other Plants: Battle Creek and Jackson, Michigan

UNITED Air Cleaners

Choice for exacting power unit duty



Feed mills, cotton gins, sawmills, agricultural implement work, industrial application — wherever power units work, air conditions fit under one general classification — bad. That is why efficient United Oil Bath Air Cleaner and Pre-Cleaner combinations are so widely specified for power unit protection.

First, the oiled and processed fine mesh screen of the pre-cleaner removes a large percentage of dust before it ever reaches the air cleaner.

Then as the air moves through the oil bath unit, it is thoroughly washed by the turbulent splash action of the oil. When the air reaches the carburetor, it is almost 100 percent dust-free — safe for precision-machined pistons, rings, bearings, cylinder walls.

United Specialties Company builds air cleaners for every kind of internal combustion engine, gasoline or diesel, for power units, automobiles, trucks, tractors and implements. Our sales engineers welcome the opportunity to discuss your requirements.

John Deere equipment is widely known for dependability and long life. Equipped with United Oil Bath Air Cleaner and Pre-Cleaner combination, this John Deere power unit is used on combines and for industrial applications.

UNITED SPECIALTIES COMPANY

United Air Cleaner Division — Chicago 28
Mitchell Division — Philadelphia 36
Birmingham 11, Alabama

AIR CLEANERS • METAL STAMPINGS • ROLLED SHAPES
IGNITION AND TURN SIGNAL SWITCHES • DOVETAILS

How Stainless makes the "Super Freighter" Super

5,000 to 8,000 Pounds Less Dead-Weight . . . 8 to 10 feet shorter, but more payload space than any standard motor truck of the same wheelbase . . .

These are characteristics of the "Super Freighter" . . . a self-propelled, large capacity trailer produced by the TWIN COACH COMPANY, Kent, Ohio.

Look at the 35-foot unit, shown here, with its body of 18-8 austenitic chromium-nickel stainless steel.

The 18-8 stainless permits use of thinner gauges *to cut dead-weight while increasing strength.* It also assures longer useful life, because chromium-nickel alloy steel has the toughness to withstand impacts and rough usage in loading and on the road.

Chromium-nickel stainless steels resist wear, abrasion from road dust, and the corrosive attacks of rain, sleet and ice, as well as corrosion from products carried. 18-8 assures long trouble-free performance, attractive appearance, cleanliness and economy.

You can forge, bend, weld, solder, punch, shear, draw and spin 18-8 stainless. Leading steel companies produce austenitic chromium-nickel stainless steels in all commercial forms. A list of sources of supply will be furnished on request.

At the present time, nickel is available for the production of austenitic chromium-nickel stainless steels and other alloys containing nickel, for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

"Super Freighter" Stainless Steel Van . . . built by TWIN COACH COMPANY, Kent, Ohio, has 33,000 lbs. payload capacity and weighs 17,500 lbs. net. Overall length, 35'. Width, 8'. Height, 12¼'. Tread, 7'-11¾". Turning radius, 39½'. Powered by FAGEOL-TWIN COACH engines of pancake design . . . originally developed for under-floor bus mounting . . . "Super Freighters" utilize standard FRUEHAUF trailers, including refrigerator and live-stock vans. In addition to use as cargo trucks, units can be easily outfitted as mobile hospitals, machine shops, field offices, stores-on-wheels, etc.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

famous everywhere

BRIGGS & STRATTON

...and equipped with

THOMPSON VALVES

Wherever small engines are used, you'll find Briggs & Stratton engines in sizes from .75 to 8.40 horsepower. These engines have worldwide reputations for dependability, economy, and versatility.

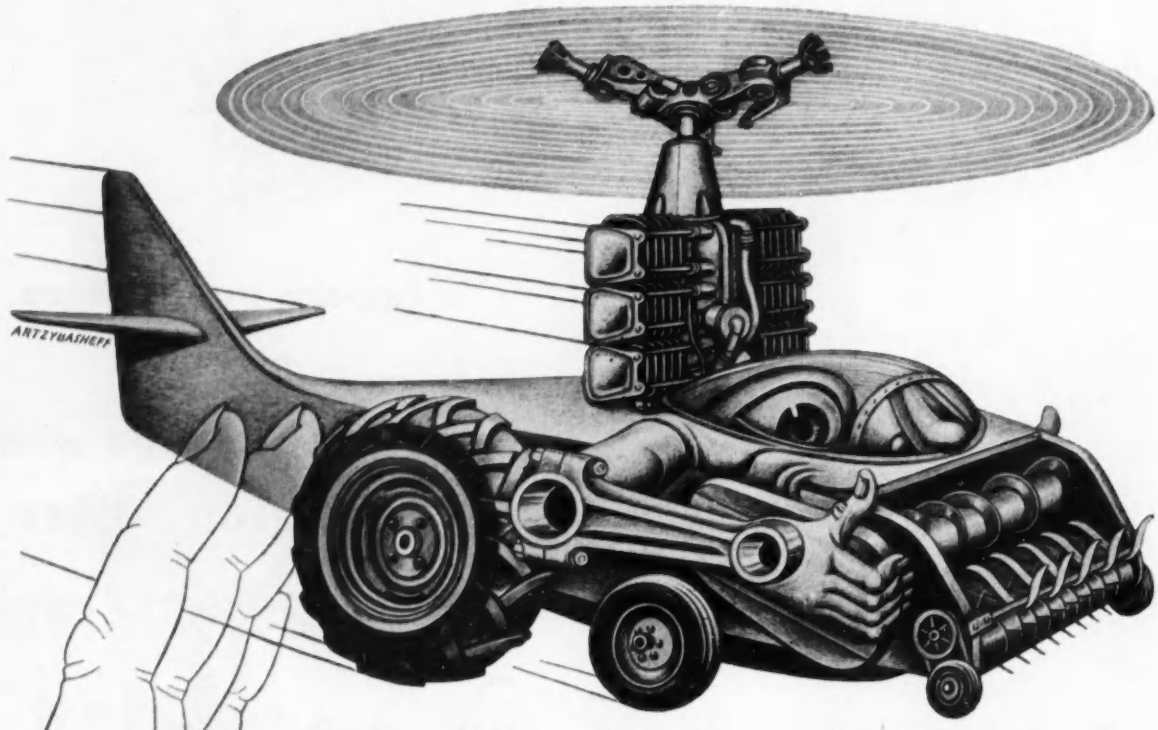
For many years The Briggs & Stratton Corporation has used valves designed, engineered, and produced by the Valve Division of Thompson Products, Inc.

What Briggs & Stratton and other leading engine manufacturers in all fields have done, you can do . . . count on Thompson's Valve Division for engineering leadership.

VALVE DIVISION

Thompson Products, Inc.

CLEVELAND 17, OHIO



The hand that helps keep America "running"

For precision production so vital to products that contribute to America's progress . . . leaders in industry look to the skilled hand of Lycoming.

This is the hand that machines vital components for GENERAL ELECTRIC J-47 jet engines . . . that turns out sturdy connecting rods for FORD trucks . . . that produces durable gears for NEW IDEA farm machinery . . . that makes rotor assemblies for PIASECKI helicopters . . . that creates air-cooled engines for executive aircraft such as AERO-COMMANDER, BEECH, GRUMMAN, RYAN and PIPER

. . . *this is the skilled hand of Lycoming precision production.*

Long on experience, varied in skills, huge in production—Lycoming always meets the most exacting metal-working requirements of leaders in American industry. So whatever your problem . . . *look to Lycoming!*

For a more complete story on Lycoming's varied abilities and facilities, write—on your company letterhead—for the illustrated booklet "Let's Look at Lycoming."

SOME OF THE LEADERS WHO LOOK TO LYCOMING

American Car and Foundry Company • Air Materiel Command • Bendix Aviation Corp. • The Cleveland Pneumatic Tool Company • Doman Helicopters, Inc. • Food Machinery & Chemical Corporation Ford Motor Company • General Motors Corporation—*Chevrolet-Aviation Engine Division* • Kaman Helicopter Corp. • Navy Bureau of Aeronautics • Piasecki Helicopter Corp. • Pratt & Whitney Aircraft Sylvania Electric Products, Inc. • Thompson Products, Incorporated • Westinghouse Electric Corporation • Wright Aeronautical.

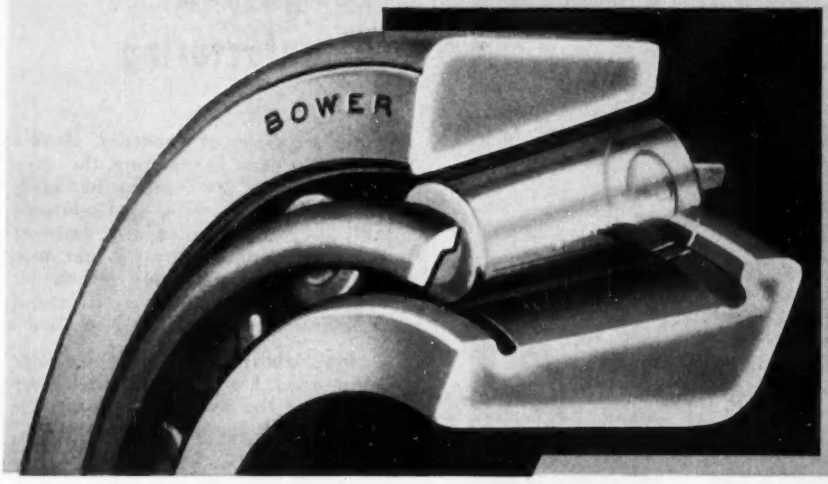
FOR RESEARCH · FOR PRECISION PRODUCTION

LOOK TO LYCOMING

Lycoming-Spencer Division, Williamsport, Pa. AVCO Bridgeport-Lycoming Division, Stratford, Conn.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

Bower spher-o-honed design provides better bearing lubrication



LARGE OIL GROOVE GIVES POSITIVE LUBRICATION TO ROLLER HEADS

The large oil groove built into Bower Spher-O-Honed bearings is just *one* of several important Bower design features which reduce maintenance and increase efficiency. Combine it with generated spherical roll-heads and a higher flange surface, and smooth, precision-honed races, and you have the basic elements of Spher-O-Honed design.

A careful look at the illustration above will show you other important Bower features, too. Note particularly that the roller heads contact the flange over a wide two-zone area—thus reducing wear and minimizing resultant "end play."

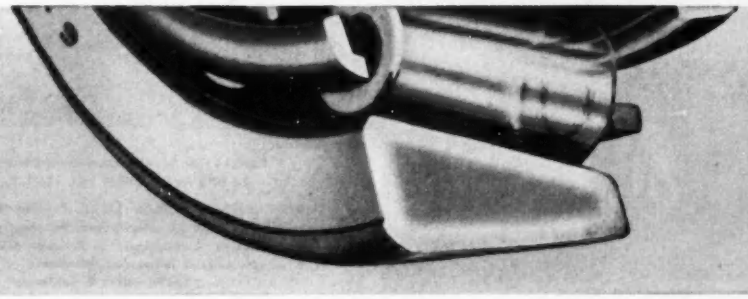
Built of the highest quality materials and workmanship, Bower bearings are available in a complete range of sizes and types to meet your present requirements. Call in a Bower engineer now!

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

BOWER

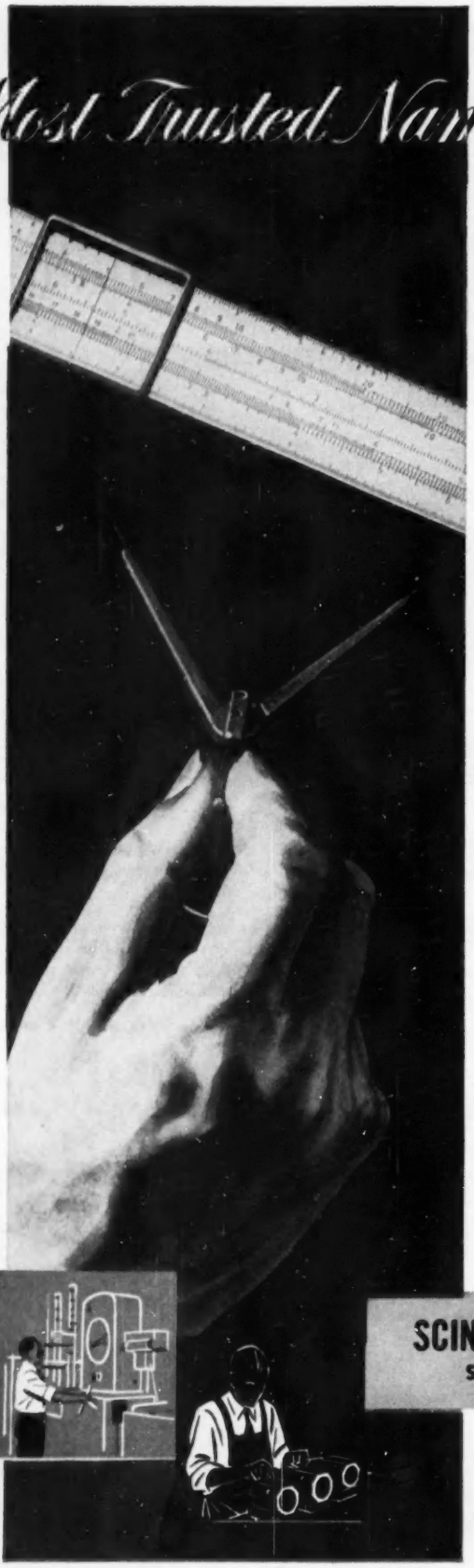
ROLLER BEARINGS

SPHER-O-HONED



A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS

The Most Trusted Name in Ignition



in research, design and manufacturing

For over a quarter of a century, Bendix has set the pace in meeting the ever changing ignition problems of the industry. It is perfectly obvious that solutions to this perpetual challenge of product improvement and application can only be found by an unceasing search for advanced design, better materials and more efficient manufacturing methods.

How well Bendix has met this challenge is evidenced by the overwhelming endorsement the aviation industry has given to Bendix ignition equipment.

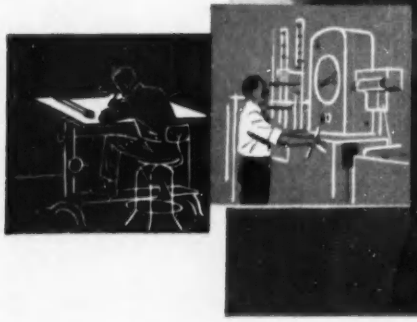
Whether the requirement is for a better electrical connector or a complete new ignition system, the industry has come to look upon Bendix as the one source best qualified to meet every ignition problem.

Remember, the unmatched facilities of Bendix aré yours to command from planning to finished product.

AVIATION PRODUCTS

Low and high tension ignition systems for piston, jet, turbo-jet engines and rocket motors . . . ignition analyzers . . . radio shielding harness and noise filters . . . switches . . . booster coils . . . electrical connectors.

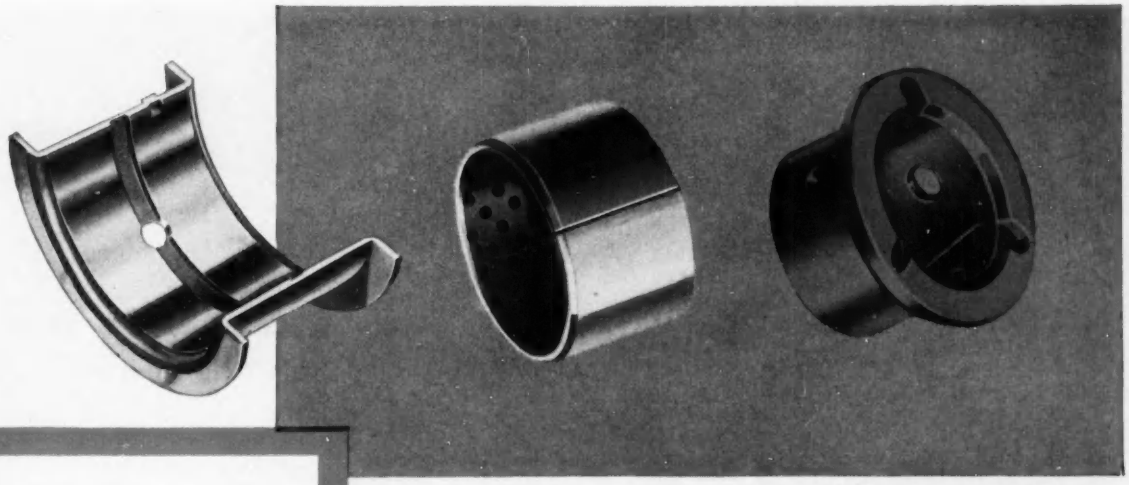
Bendix

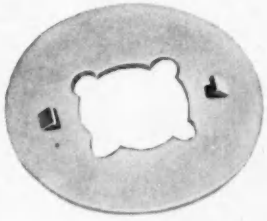


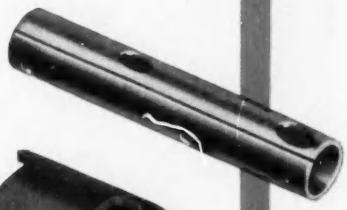
SCINTILLA MAGNETO DIVISION
SIDNEY, NEW YORK

Export Sales: Bendix International Division
72 Fifth Avenue, New York 11, N. Y.

FACTORY BRANCH OFFICES: 117 E. Providencia Avenue, Burbank, California • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • 582 Market Street, San Francisco 4, California







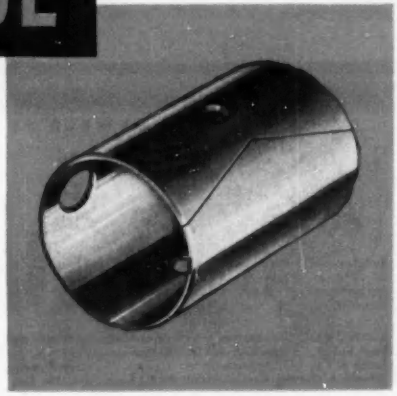
Products of our six plants include: Sleeve bearings in all designs and sizes; cast bronze bushings; rolled split-type bushings; bi-metallic rolled bushings; washers; spacer tubes; precision bronze parts and bronze bars.

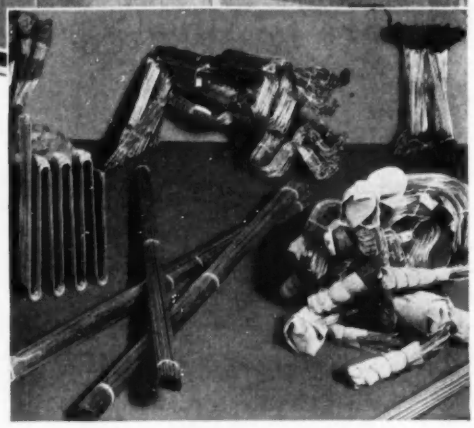
SINCE 1899

FEDERAL-MOGUL

FEDERAL-MOGUL CORPORATION

11035 SHOEMAKER, DETROIT 13, MICH.





You know that brake, gasoline, and oil lines of Bundyweld Tubing are leakproof, completely dependable. You've probably taken advantage of Bundy's complete fabrication services or specialized engineering help.

And now: custom-engineered packaging of fabricated or straight-length Bundyweld brings your plant new handling convenience, additional savings.

Your fork-lift trucks handle these new pallet packs easily, speedily; stack them to almost any height (above). New packaging, compared with once-standard method (inset), prevents tube damage, part tangling, saves handling costs.

And now: Bundy custom-engineered packaging eases handling, saves costs

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness,

and passed through a furnace. Copper coating fuses with steel. Result . . .

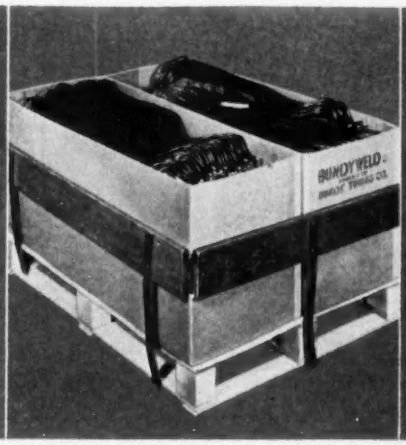
Bundyweld, double-walled and brazed through 360° of wall contact.

←

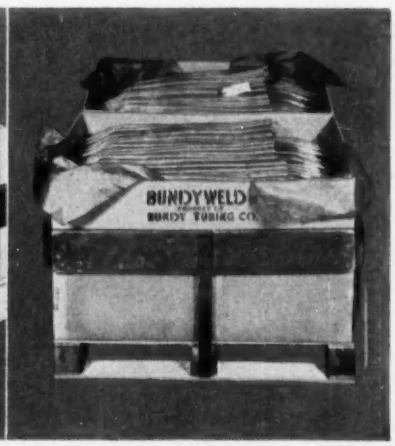
NOTE the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St. East • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

Custom-engineered packages are made up by selection of the properly sized corrugated "component" for particular parts. Vacuum windshield-wiper tubes ship and store most safely, economically in one-component packs. Wooden "girth" fastened about component during packing assures alignment on pallet, prevents bulging. Tubes are bound in groups to prevent tangling.



Best shipping, storage efficiency is gained by sizing components exactly to each different Bundyweld part. Eleven styles are used, ranging from 23½" x 17½" x 10" up to 47½" x 35½" x 32". Two components carrying these armored brake tubes fit squarely on a 36" x 48" expendable, four-way-entry pallet, won't shift in transit whether stapled or banded.



New handling, storage ease is seen sharply in packaging of these tinned Bundyweld heater tubes. Kraft components (every one certified by 275-600-lb. test) permit this pallet pack, with total weight of 1500 lbs., to carry 2000 tubes. Old shipping method involved separate handling of 80 loose bundles. Despite weight, new pack is handled easily by fork-lift.

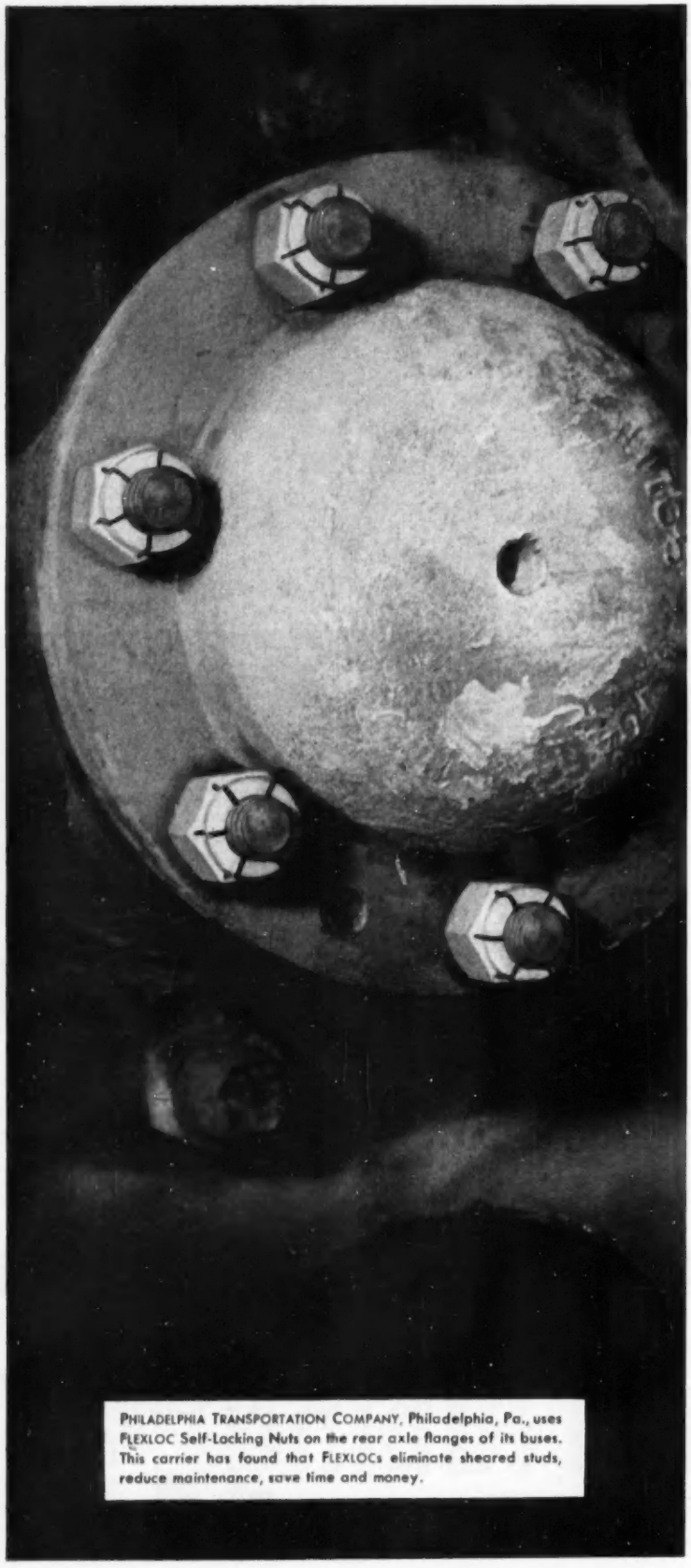
Care taken in Bundy packaging, delivery is seen in the palletizing of this four-component pack of brake tubes. Wooden corner-inserts help reinforce package in transit, add extra strength at right places for increased stackability in storage. Tubing is protected against rubbing or possible moisture seepage from all inserts by covering of treated semi-liner.

Custom-engineered packaging adapts deliveries to exact needs. For storage and production flow on multiple-shift basis, a customer needed small, easily handled components that could be taken from pallets individually. Solution: six-component pack, units banded to pallet without stapling. Corrugated cover for whole pack defeats shifting problem, adds protection.

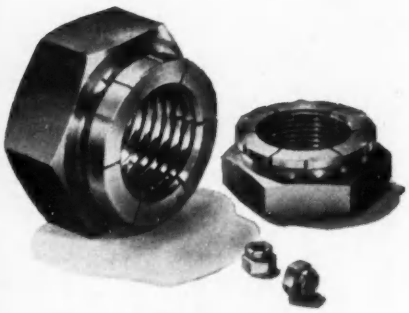
Bundyweld fabricated parts or straight-length tubing can be used with efficiency directly from shipping package. On shipments for local-area customers, Bundy's own truck fleet delivers the order right on schedule in these heavy-duty, steel returnable containers. Smaller sizes than those above can be raised to working height by using standardized metal stands.

Bundyweld Tubing®

DOUBLE-WALLED FROM A SINGLE STRIP



PHILADELPHIA TRANSPORTATION COMPANY, Philadelphia, Pa., uses FLEXLOC Self-Locking Nuts on the rear axle flanges of its buses. This carrier has found that FLEXLOCs eliminate sheared studs, reduce maintenance, save time and money.



How FLEXLOC locknuts work

FLEXLOCs lock and stay put on a threaded member regardless of the vibration encountered. Here's how they work. The slotted top or locking section is divided into six equal, flexible segments, closed in to make the inside diameter of the nut smaller than that of the companion bolt. When the FLEXLOC is applied, these are expanded by the bolt. The spring tension of the resilient segments locks the nut securely at any desired position on the bolt once the locking threads are fully engaged.

FLEXLOCs can be used over and over again. When expanded by the bolt, the locking section remains within the elastic limit of the metal. This permits the locking segments to return to their normal position, ready for reapplication to the bolt.

FLEXLOCs are one piece, all metal—nothing to assemble, come apart, lose or forget. They can be delivered in any quantity in a wide range of sizes. Stocks are carried by industrial distributors everywhere. Write for literature and samples. SPS, Jenkintown 55, Pa.

FLEXLOC®

LOCKNUT DIVISION

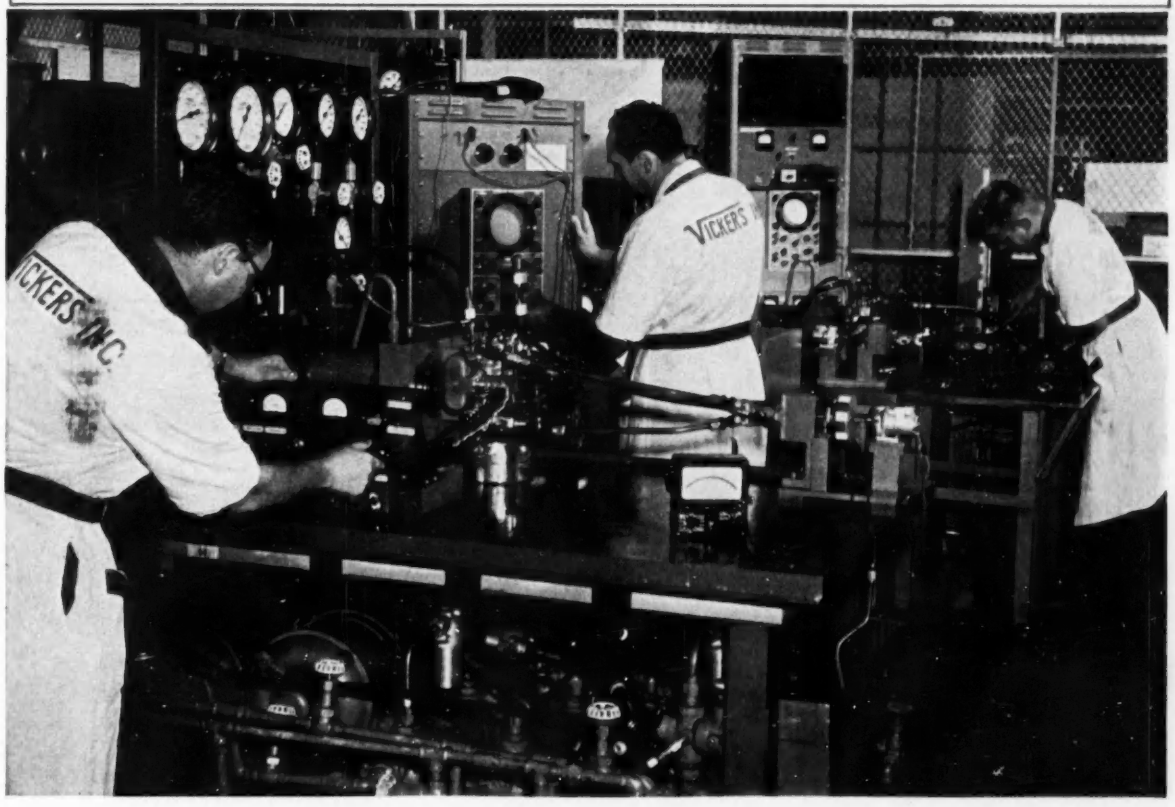
SPS

JENKINTOWN PENNSYLVANIA

Our Fiftieth Year : A START FOR THE FUTURE

ONE OF A SERIES

You Get Many Benefits by Specifying VICKERS Hydraulics



Research | that means improved oil hydraulic equipment

The list of pioneering developments in hydraulics contributed by Vickers research is long and impressive. Among the most important are:

Hydrostatic Relief Valve • Commercial Power Steering • Balanced Vane Type Pump • Flow Control Compensator • Axial Piston Pump and Motor

These are fundamental developments that have been of vital importance in the progress of hydraulics. They are representative of a large line of equipment that, with Vickers experienced application, assures you the best in any type of hydraulic operation. Vickers, with unmatched laboratory and basic research facilities, continues to lead the way in the oil hydraulics industry.

VICKERS Incorporated
DIVISION OF THE SPERRY CORPORATION
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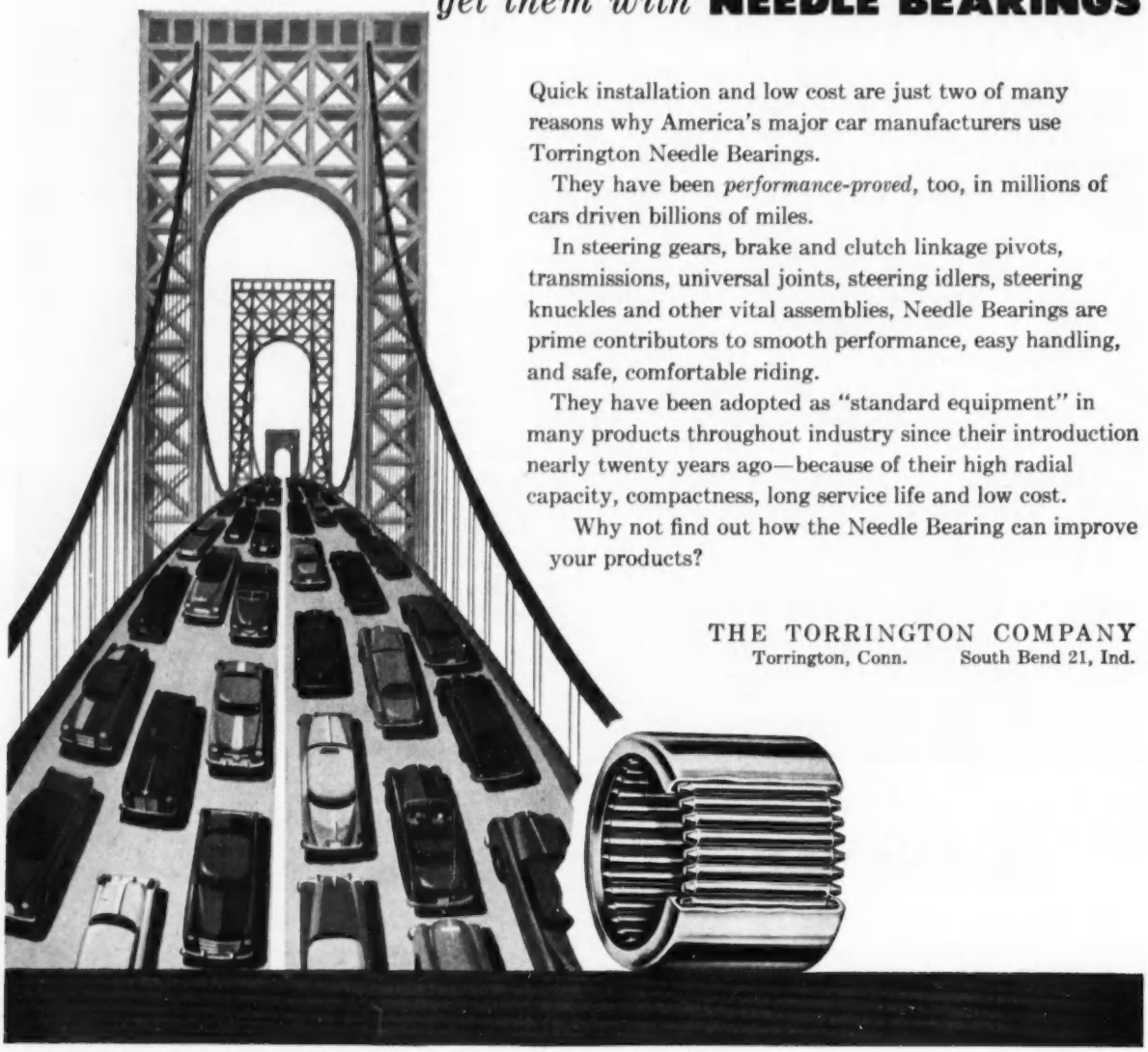
Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) • CINCINNATI • CLEVELAND DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • PHILADELPHIA PITTSBURGH • ROCHESTER • ROCKFORD • SEATTLE • TULSA • WASHINGTON • WORCESTER

6357

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

Are Easy Assembly and Low Cost "Musts" for You?

Here's how leading automobile manufacturers get them with **NEEDLE BEARINGS**



Quick installation and low cost are just two of many reasons why America's major car manufacturers use Torrington Needle Bearings.

They have been *performance-proved*, too, in millions of cars driven billions of miles.

In steering gears, brake and clutch linkage pivots, transmissions, universal joints, steering idlers, steering knuckles and other vital assemblies, Needle Bearings are prime contributors to smooth performance, easy handling, and safe, comfortable riding.

They have been adopted as "standard equipment" in many products throughout industry since their introduction nearly twenty years ago—because of their high radial capacity, compactness, long service life and low cost.

Why not find out how the Needle Bearing can improve your products?

THE TORRINGTON COMPANY
Torrington, Conn. South Bend 21, Ind.

TORRINGTON NEEDLE BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

Trade Marks of 12 of the 18 passenger car manufacturers, all of whose cars enjoy the benefits of Needle Bearings.

STUDEBAKER · CHRYSLER · DODGE · HUDSON · Packard · DeSoto · WILLYS · Nash · KAISER · LINCOLN · Ford · MERCURY

Aeroquip

REG. TRADE MARK

"little gem" fittings*

aeroquip did it again!
Another Important Development
in Detachable, Reusable
Hose Fittings!
KNIFE-LIKE SPUR separates hose inner tube and reinforcing wire braid during assembly.
CLAMPING ACTION, between nipple and socket, is exerted on reinforcing wire braid only.
POSITIVE LIP SEAL is formed by end of inner tube in annular chamber.

Here's another great Aeroquip first . . . *"little gem"* Fittings with radically new features never before seen in the industry! These amazing new fittings were especially designed to prolong the life of certain types of hose made of rubber or rubber-like materials, and plastics. Under extreme compression these materials tend to take a definite set and flow away from the zone of compression. This action is accelerated by heat. Through advanced research, development, and engineering, Aeroquip was able to provide the answer to this problem. *"little gem"* Fittings are now in production for Anti-Icing Hose Lines used on aircraft jet engines, and Steam Hose Lines in the industrial field.

*An Aeroquip Trade Mark

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SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

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PISTON RINGS

Manufacturers have recognized the
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For Piston rings to meet every requirement
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our engineering know-how is at your disposal.

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FOR YOUR CAR

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This is the newest Lockheed commercial airplane — the beautiful Lockheed Super Constellation. As pictured here, it shows what Rohr is famous for — building power packages for it and other world-famed commercial and military planes. Of course, Rohr Aircraftsmen do more than this. Currently they are producing more than 25,000 parts for all types of airplanes.

power packages by

ROHR

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES

ROHR AIRCRAFT CORPORATION CHULA VISTA AND RIVERSIDE CALIFORNIA

CLOSE-COUPLED POWER TRANSMISSION PROBLEMS LIKE THESE:

The new "Courier" Skyview sight-seeing bus manufactured by Motor Coach Industries, Ltd., Winnipeg, Canada.

50N Series Assembly. Only 18" overall with 22½° angularity.

SOLVED for SURE

with BLOOD BROTHERS propeller shafts

On rear-engine buses, power must be transmitted from engine to differential with allowance for extreme angularity. Yet performance must be smooth, efficient and dependable.

When bus manufacturers like Motor Coach Industries, Ltd., specify Blood Brothers Propeller Shafts, it's obvious that these components meet all tests. The 50N Series Assembly is tough, long-lived and carefully balanced—like *all* Blood Brothers Drive Lines.

When *you're* up against truck or bus propeller shaft problems, call on our engineering department for suggestions. Perhaps *your* problem can be solved for sure— with Blood Brothers Drive Line Assemblies.

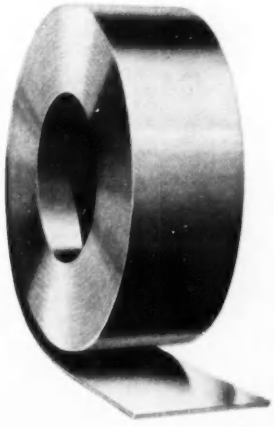
BLOOD BROTHERS machine co. ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

A Division of Standard Steel Spring Co. • Chicago Office: 122 S. Michigan

— another instance where

Superior Stainless *shines!*



The stainless steel windshield wiper on your car does a sparkling job when the going is wet . . . stays bright and rustless over years of exposure to the worst of weather . . . and is very likely to be made of SUPERIOR Stainless Strip Steel. As original equipment on a variety of cars, and sold by thousands of service stations, garages, car dealers and supply stores, windshield wiper arms and blades of Superior Stainless highlight in service the quality of their metal. ● Can we help you with *your* projected applications?

Superior Steel

CORPORATION

CARNEGIE PENNSYLVANIA

NEW HEATER-DEFROSTER

SMALLER IN SIZE ...BIGGER IN OUTPUT!

The new EVANS ED-75

Provides more heat output than any other heater-defroster of its size

SMALL
only 8-1 16" x 8-5 16" x 8-3 8"

POWERFUL
17,800 BTU Output

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split core and tank travel water further — heat lingers longer

HEAVY DUTY
"Continuous service" bus type motor — heavy duty truck service core

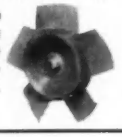
ADAPTABLE FOR RECIRCULATING OR FRESH AIR
Simple to connect to top or side cowl for fresh air intake

Each Evans unit is custom engineered for its specific vehicle installation, to provide a completely satisfactory heating and ventilating system. Evans units are available for a wide variety of commercial vehicle applications.

The Evans organization is staffed to engineer units to specification, organized to build prototypes quickly, equipped to conduct precision tests to latest A.S.H.V.E. procedures. Military experience dating back to World War I qualifies Evans to work with you in meeting the rigid specifications of the Armed Forces. If your needs are for high performance, ruggedly constructed equipment–it will pay you to consult Evans Products Company, Heating & Ventilating Division, Dept. Z-7, Plymouth, Mich.

EVERY EVANS HEATER IS EQUIPPED WITH THE FAMOUS EVANS UNBREAKABLE LIGHTWEIGHT FAN

Precision die-molded airfoil section blades . . . move more air with less noise and current draw . . . will not chip, crack or bend . . . unaffected by temperature . . . one piece construction.



EVANS — BALANCED HEATING & VENTILATING **CUSTOM HEATERS** FOR EVERY TRUCK AND BUS

Mechanical Springs by Eaton

As a source of large volume and difficult mechanical springs, Eaton Spring Division offers the most modern of spring production facilities plus a background of more than twenty years in this specialized field. Consulting with Eaton Spring engineers often leads to simplification and worthwhile economies in spring requirements.

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proved in automatic **transmissions**

MORAINE friction materials

OFFER IMPORTANT ADVANTAGES IN MANY APPLICATIONS

(Parts shown are typical)

Moraine friction materials established their reputation in automatic transmissions such as Powerglide, Dynaflow and Hydra-Matic. The success of Moraine friction materials for clutch plates and bands has encouraged their use for other and wider applications which have given better performance at lower cost to a variety of mechanisms. Special military equipment, household appliances, automatic transmissions for commercial trucks of every size, and military vehicles have benefited as a result of these developments. On the basis of our experience and ability, we may be able to help you improve *your* product.

moraine products

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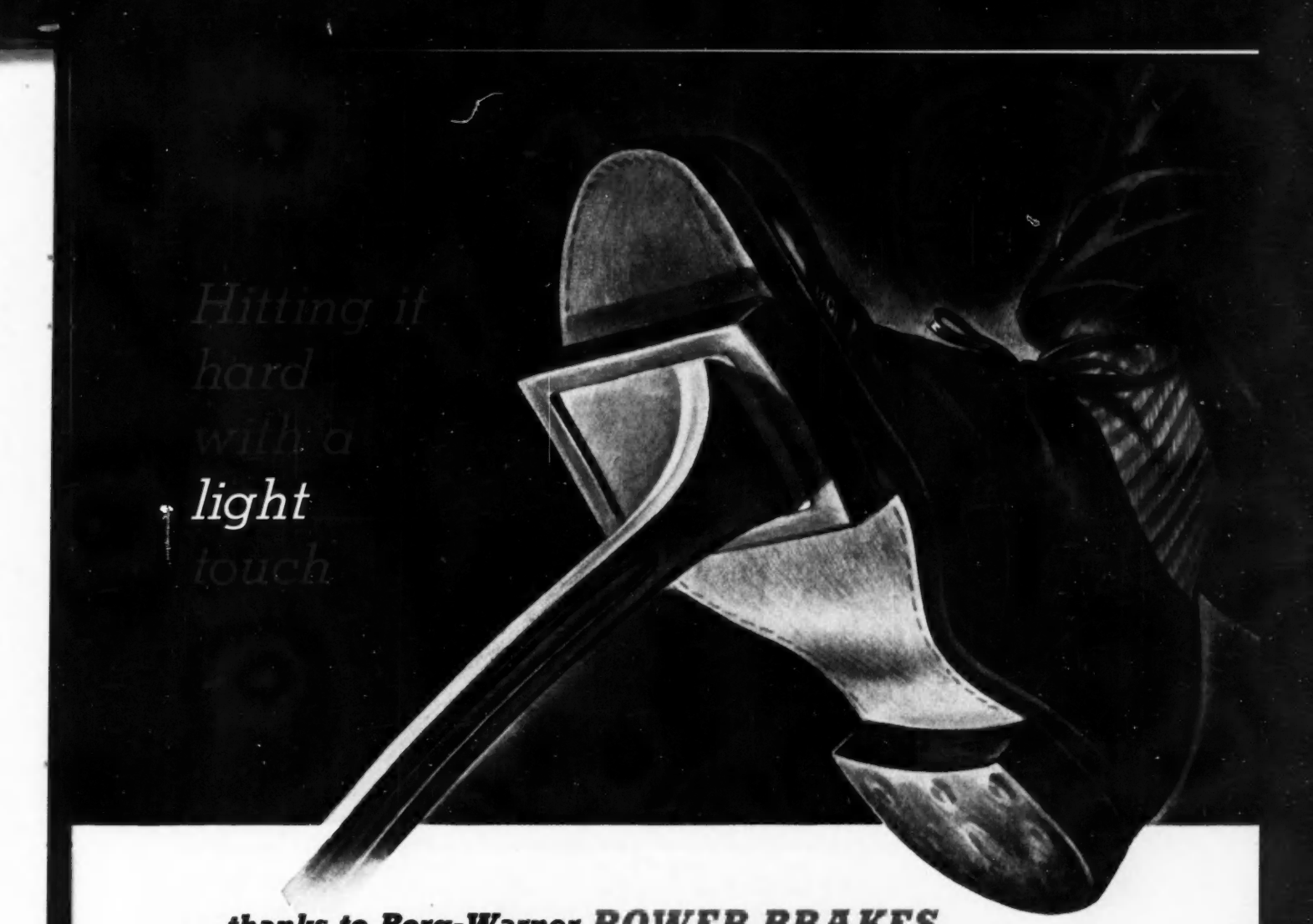
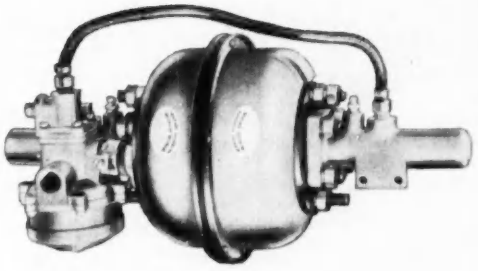


...thanks to Borg-Warner POWER BRAKES



Just a light touch, an *e-a-s-y* pedal pressure, and Borg-Warner power brakes take hold. Instantly. Smoothly. Firmly. Braking power is stepped up—for quicker, surer, safer stops, with a fraction of the effort. This means more efficient braking—plus greater driver comfort, less strain, less fatigue.

What's more, Borg-Warner power brakes have a minimum of wearing parts, require no lubrication, and are not affected by climatic conditions. That means longer life, lower maintenance costs, greater dependability. Unusually compact, units are easily installed in existing brake systems.

Available for passenger cars, trucks, tractors and trailers, Borg-Warner power brakes are designed, engineered and produced by B-W's Marvel-Schebler Products Division. Another example of how Borg-Warner "designs it better—makes it better." One more way Borg-Warner serves the automotive industry—and the public—every day.

B-W *engineering makes it work*

B-W *production makes it available*

Almost every American benefits every day from the 185 products made by

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ENGINEERING B-W PRODUCTION

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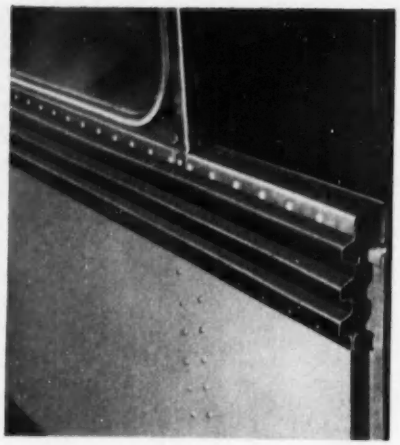
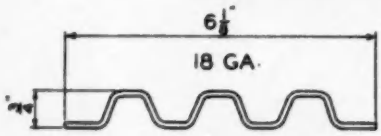
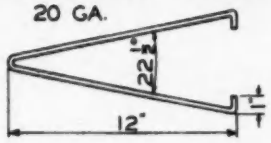


ONE OF THESE
MAYARI R SHAPES
MAY GIVE YOU AN IDEA



MILL LENGTHS



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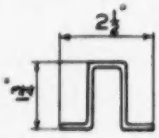

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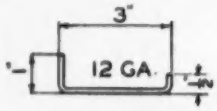

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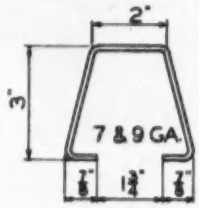

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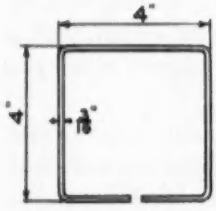

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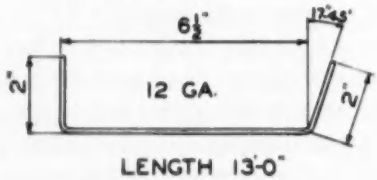

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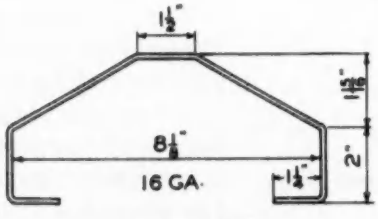

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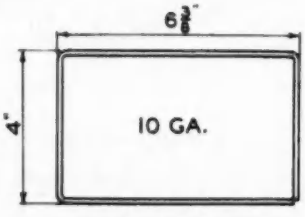


LENGTH 7'-9"

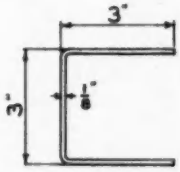
There are dozens of automotive applications for Mayari R cold-formed shapes . . . rub rails for buses . . . box sections for truck frames . . . channel sections for trailer body members . . . and many others that will occur to you when you study these drawings.

These shapes are formed or rolled to the exact dimensions you require, without any waste material. They are easy to cut and assemble. And they can be welded by the usual methods used for carbon steel.

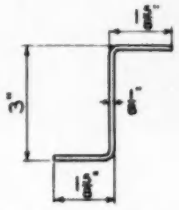
Mayari R, our low-alloy, high-strength steel, has a yield point of 50,000 psi minimum, almost twice that of plain carbon steel. This means that lighter gages can be used to reduce deadweight without sacrificing strength. Mayari R also has from 5 to 6 times as much resistance to atmospheric corrosion as plain carbon steel, and 2 to 4 times that of copper-bearing steel.

Consider these made-to-order sections with the thought of improving the design of your products, reducing deadweight, or cutting production costs. We'll be glad to help you work out a shape that will meet your needs. Get in touch with any Bethlehem sales office, or write to us at Bethlehem, Pa.

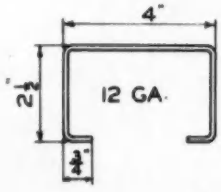
BETHLEHEM STEEL



LENGTH 10'-0"



MILL LENGTHS



LENGTH 13'-0"

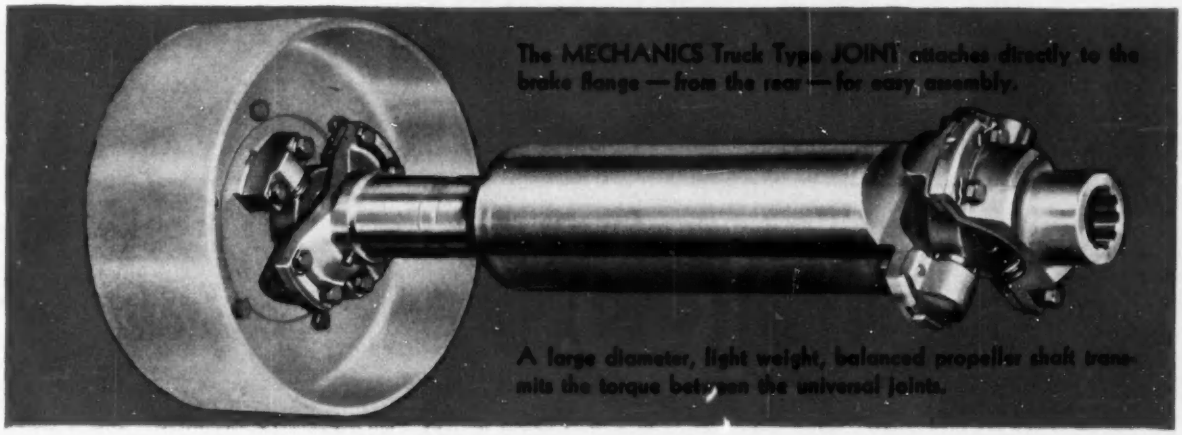
BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

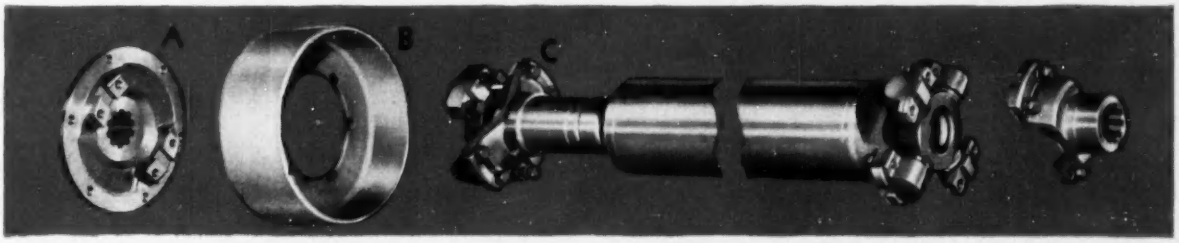
Mayari R *makes it lighter... stronger... longer lasting*

ALL Universal Joints — Are NOT Alike

MECHANICS Roller Bearing UNIVERSAL JOINTS for Trucks are specially designed with less parts and connections for *easy assembly* and *servicing* — *smooth running balance* — *Maximum strength* with *less weight* — and *long, trouble-free, safe operation.*


The MECHANICS Truck Type JOINT attaches directly to the brake flange — from the rear — for easy assembly.
A large diameter, light weight, balanced propeller shaft transmits the torque between the universal joints.

MECHANICS Truck Type JOINTS are assembled by attaching joint C to brake flange A independent of fastening between drum B and flange A, making possible servicing drum or joint, without disturbing other attachments or altering original brake drum or propeller shaft balance.



Let MECHANICS engineers help give *your* trucks or other heavy duty machines these competitive advantages.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2022 Harrison Avenue, Rockford, Illinois

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Roller Bearing BW
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

QUIETER OPERATION

SMOOTHER PERFORMANCE

BETTER SERVICE

LONGER LIFE

For more than 35 years the Automotive Industry has found you can always depend on clutches by

BORG & BECK®

For that vital spot where Power takes hold of the load!

BORG & BECK CLUTCH · THE STANDARD

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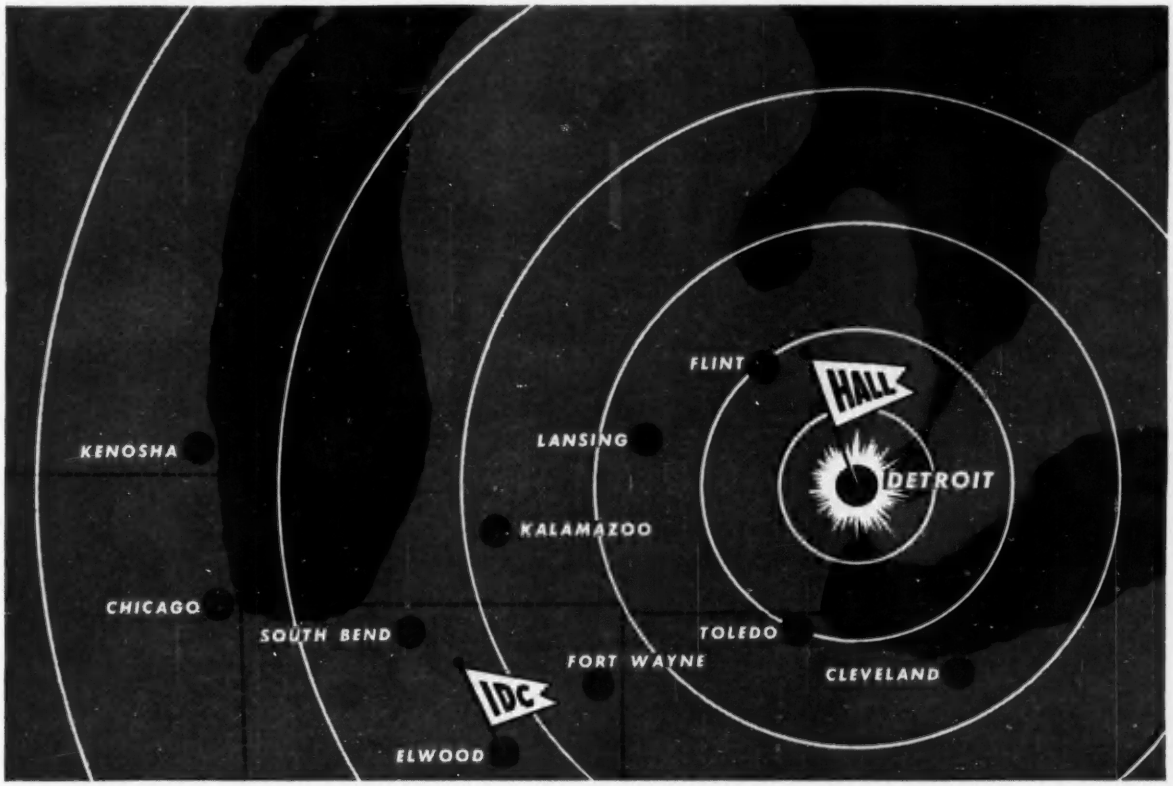

Bright-Spot in the Transportation Center

DETROIT'S high-speed automotive production lines make split-second supply and immediate service absolute necessities.

The C. M. HALL LAMP COMPANY is the bright-spot at the hub of this vital industry . . . the only complete manufacturer of lighting equipment so centrally located for both supply and service.

Time after time customers have expressed their "thanks" for the all-inclusive service C. M. HALL provides for them. Costly shutdowns are avoided as the C. M. HALL LAMP COMPANY gears to everchanging schedules.

C. M. HALL LAMP COMPANY, with its subsidiary, INDIANA DIE CASTINGS, INC., manufactures over 200 different kinds of transportation lights. Since 1909 we have worked hand-in-hand with the leaders of the industry to develop new and better lighting . . . to improve America's VISION FOR TRANSPORTATION.

C.M. HALL Lamp Company

Vision for Transportation

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and its wholly-owned subsidiary INDIANA DIE CASTINGS, INC. ELWOOD, INDIANA

Gas engines or Diesel . . . South quick starting

Model 97B MF
20,000 BTU/hr.
fresh air output

from one heater...

engine pre-heating plus personnel heating plus defrosting. Models for every requirement.

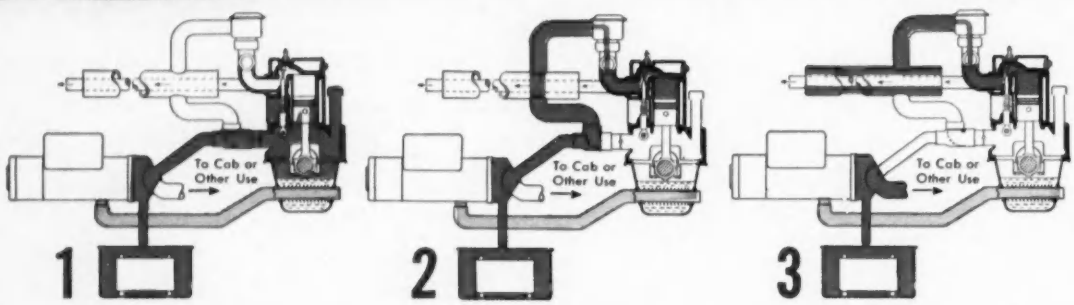
Here's powerful, *sure* pre-heating for brutally tough-to-start diesels as well as gas engines of every type. Compact, adaptable, dependable South Wind Pre-Heating Systems assure the quick starting required by Military Services even at 65° below! One heater provides engine pre-heating – cab heating – defrosting!

South Wind Pre-Heating Systems reduce battery drain by reducing starting torque, cut the cost of starting aids. They eliminate shock loads imposed by brute-force starting methods, prolong engine life and lower maintenance cost.

Only clean, *dry* air is fed to engines by South Wind Pre-Heating Systems. They permit use of optimum viscosity lubricants and assure normal lubrication at all times. Inhibit sludge formation and freeze-up of engine accessories, too.

South Wind's equipment for internal and external pre-heating includes units of 20,000, 30,000, 50,000, 60,000, 90,000, 100,000, 200,000, 600,000 and 700,000 BTU/hr. capacity. South Wind's experienced field engineers will be happy to consult with you on any pre-heating problem, whatever its scope or complexity. Write today to: South Wind Division, Stewart-Warner Corporation, Indianapolis, Indiana.

South Wind 3-Phase INTERNAL PRE-HEATING



Pre-Heat Phase

Clean, *dry* hot air is used to pre-heat critical engine moving parts directly and to remove damaging moisture from the engine interior *—before engine cranking is attempted.* (Note: Heat duct to the cab for heating and defrosting remains closed until after the engine is started.)

Starting Phase

Heat into engine crankcase is diverted (as shown) to air induction system to elevate temperature of fuel-air mixture and promote rapid, normal combustion in chambers. Internal pre-heating of critical parts and normal lubrication frees bearings, shafts, pins and pistons from starting strain and friction wear.

Operational Phase

After easy starting, normal engine operating conditions are sustained. Now, South Wind's clean heat can be used to heat the cab, defrost windshields and supply engine induction air heat. (Note: Illustration shows how normal engine induction air temperature can be sustained by engine exhaust heat exchanger.)

Wind pre-heating systems assure even at 65° below!

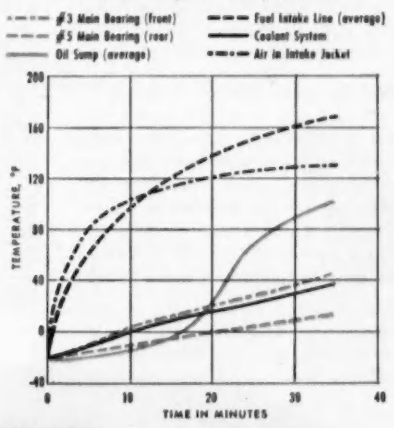
Studies Prove South Wind Superiority

South Wind's entirely new principle of scientific pre-heating has been developed, tested and proved *in the field*, as well as in Stewart-Warner's Laboratory Cold Room.

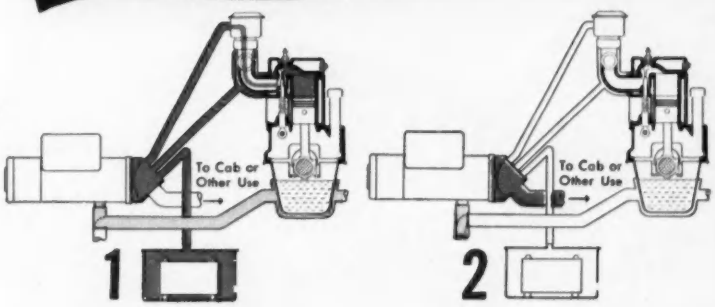
Here is typical temperature record of critical engine components during pre-heating (only minimum capacity 70,000 BTU/hr. pre-heater kit used). This heat provided adequate temperature rise for easy starting—with less than 5-seconds cranking.

Data is based on a 6-cylinder, 2-cycle 225 HP Diesel engine weighing 3,000 pounds.

Temperature vs. Time of Diesel Engine Components



South Wind 2-Phase EXTERNAL PRE-HEATING



Pre-Heat Phase

Clean, *dry* hot air is applied to the exterior surface of the carburetor and intake manifold, and to the battery, by the use of shrouds. The oil sump is heated in like fashion by hot gases from the heater exhaust. (Clean, hot air which enters the air intake is, in some cases, provided for the starting phase.)

Operational Phase

After starting engine, clean, hot air from the heater is diverted to cab for personnel heating, defrosting and other use. (If the application demands, part of this air can be used to provide continuous heat for battery and/or air induction system.) Heater exhaust is diverted directly to atmosphere.

Model 1060
60,000 BTU/hr.
fresh air output

Model 1030
30,000 BTU/hr.
fresh air output

South Wind
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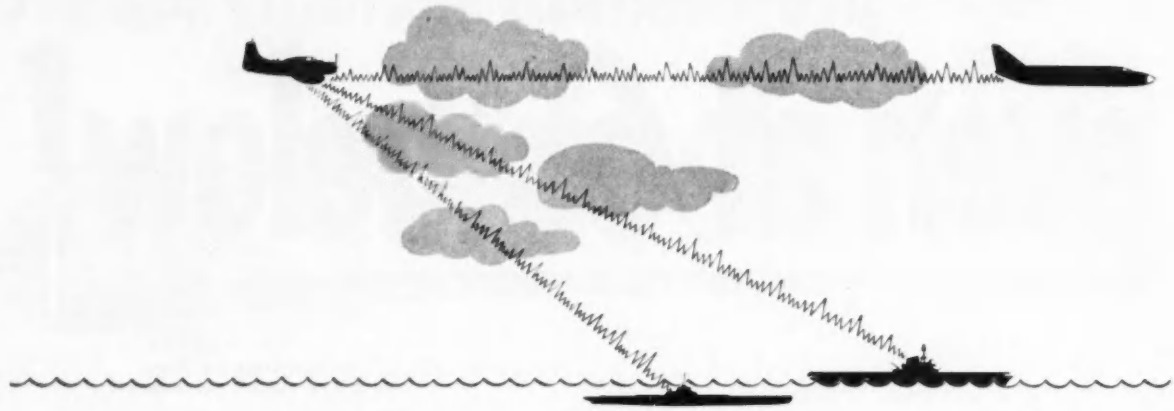
PERSONNEL HEATING
ENGINE AND
EQUIPMENT PRE-HEATING
WINDSHIELD DEFROSTING

U. S. Navy's most versatile plane
stalks enemy planes, subs and surface craft



—the Douglas AD-5 Skyraider

Known for varied tactical uses—long-range attack, troop transport, close air support, aircraft early warning—the Douglas AD-5 is also capable of unique search and anti-submarine missions.

In this operation the AD-5 carries powerful radar equipment and a search-light to detect and identify the enemy, whether on the surface, under the sea or in the air. Rockets, cannon, and torpedoes are used to make the kill. Key feature of the Skyraider is its efficient performance-to-weight ratio, which gives it extraordinarily long range—plus all the fire-power of a cruiser's full salvo.

Adaptability of the AD-5 Skyraider is another example of Douglas leadership in aviation. Designing airplanes that can be produced in quantity to fly *faster and farther with a bigger payload* is a basic rule of Douglas design.

Be a Naval flier—write to:
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Depend on *DOUGLAS* **First in Aviation**

NATIONAL OIL SEAL LOGBOOK

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Sealing News & Tips

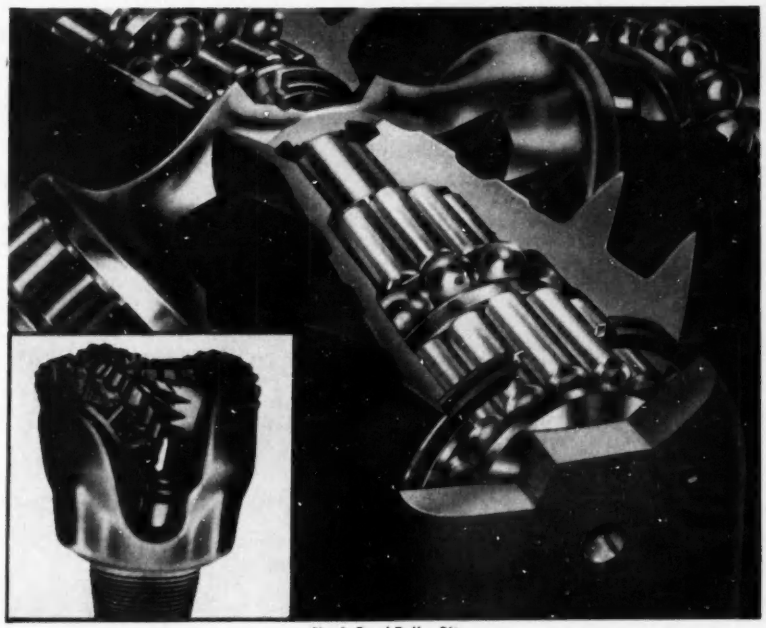

Fig. 1. Reed Roller Bit

National Syntech* Oil Seals lengthen life, improve performance of Reed roller bits

The conditions under which rotary rock bits operate are extremely severe. To lengthen bit life, improve performance and limit admission of abrasive materials from cutter bores, Reed Roller Bit Company utilizes National Oil Seals in their heavy-duty rock bits.

Three National seals—two standard design 360,000 series and one special design face seal—are installed in each bit. These seals are of springless design with precision-trimmed sealing lips of National Syntech synthetic rubber (Figure 2). The inherent "flex" action of the Syntech lip insures satisfactory sealing despite runout and the heavy impacts of rock drilling. The Reed Company reports that "Bits containing seals are in noticeably better condition than bits not containing seals—both being run under the same conditions and for the same length of time."

The National Oil Seals in this application illustrate but two of thousands of National designs. Perhaps your product can benefit by utilizing standard design National seals; perhaps special seals are required. In either case, our long experience with sealing problems is at your disposal.

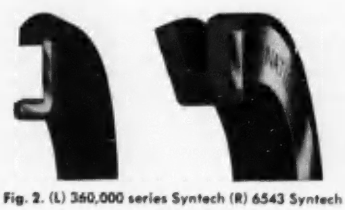

Fig. 2. (L) 360,000 series Syntech (R) 6543 Syntech

*T. M. Reg.

National 350,000 series with flange case

To simplify installation, many users specify National Oil Seals with flanges. Illustration shows a standard design National 350,000 series Syntech* Oil Seal with bolt-on flange. This spring-tensioned design with synthetic rubber sealing lip is often specified in applications involving high speeds and high temperatures.

National 50,000 series, modified

A standard design National seal, modified, with special flange. O.D. of flange press fits into housing. National 50,000 series leather seals such as this (with and without flange) are ideal for heavy-duty applications where seals may run semi-starved and external dirt or dust conditions are severe.

National O-Ring Catalog

National, a world leader in oil seals, now offers a complete line of standard size commercial grade O-Rings. See the nearest National Applications Engineer for complete details or write direct for new National O-Ring catalog.

"Let Your Decision be Based on Precision"

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OIL & GREASE SEALS
O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

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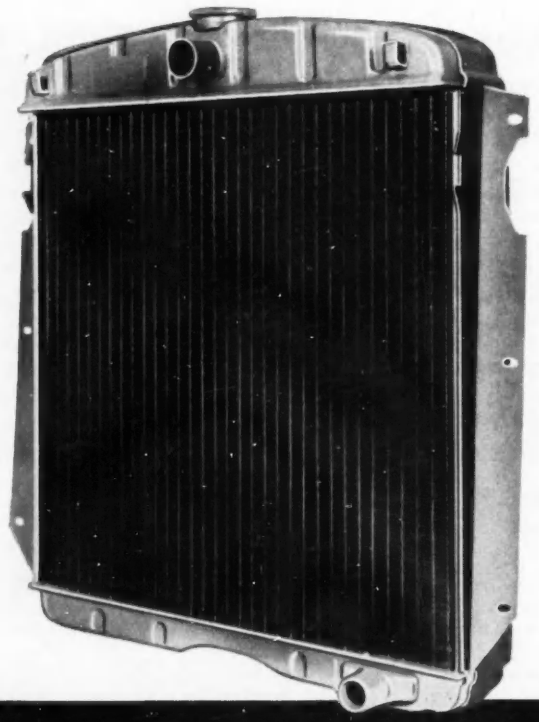
Forty-two years ago we began the design and manufacture of units for automotive cooling systems.

Today—fifty-three million radiators later—our accumulated knowledge and experience, plus our modern research and testing facilities, qualify us to handle any automotive cooling requirement.

Take your cooling problems to Harrison . . . for Harrison has the answers!



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RADIATOR
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GENERAL MOTORS CORPORATION
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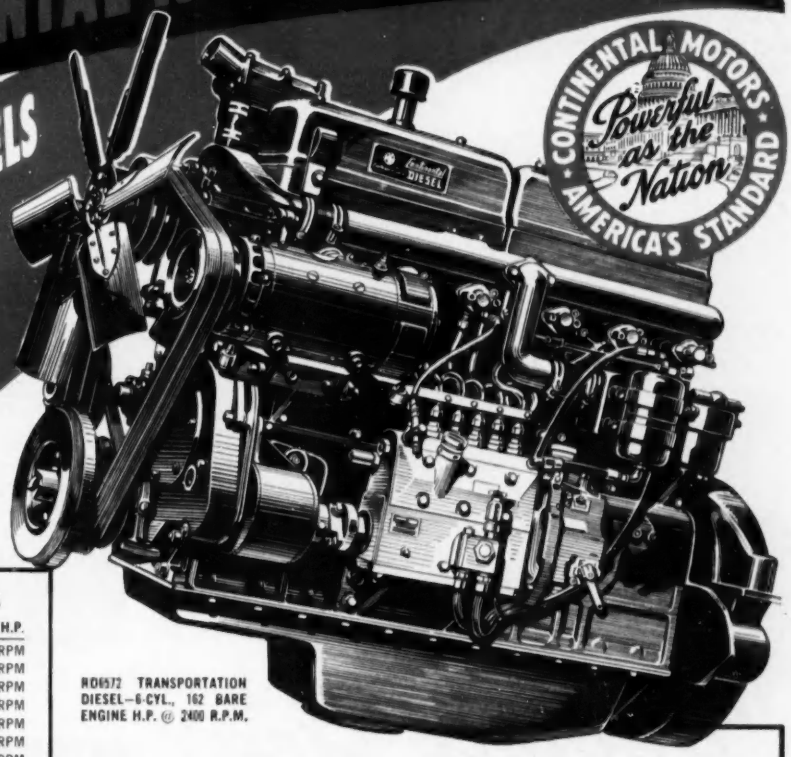
YOU'LL GO FAR with CONTINENTAL RED SEAL POWER

28 BASIC MODELS FOR TRUCKS AND BUSES



RD6572 TRANSPORTATION DIESEL—6-CYL., 162 BARE ENGINE H.P. @ 2400 R.P.M.

TRANSPORTATION GASOLINE ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
N4062	4	2⅛	3½	62	26 @ 3400 RPM
Y4069	4	2½	3½	69	28 @ 3400 RPM
Y4091	4	2⅞	3½	91	36 @ 3400 RPM
F4124	4	3	4⅛	124	47 @ 3200 RPM
F4140	4	3 3/16	4⅛	140	52 @ 3200 RPM
F4162	4	3 7/16	4⅛	162	58 @ 3200 RPM
F6186	6	3	4⅛	186	77 @ 3500 RPM
F6209	6	3 3/16	4⅛	209	90 @ 3500 RPM
F6226	6	3 5/16	4⅛	226	99 @ 3500 RPM
M6271	6	3⅛	4⅛	271	97 @ 3000 RPM
M6290	6	3⅜	4⅛	290	108 @ 3000 RPM
M6330	6	4	4⅛	330	125 @ 3000 RPM
K6271	6	3⅛	4⅛	271	115 @ 3200 RPM
K6290	6	3⅜	4⅛	290	123 @ 3200 RPM
K6330	6	4	4⅛	330	145 @ 3200 RPM
B6371	6	4⅛	4⅛	371	124 @ 3000 RPM
B6427	6	4 5/16	4⅛	427	142 @ 3000 RPM
T6371	6	4⅛	4⅛	371	144 @ 3000 RPM
T6427	6	4 5/16	4⅛	427	170 @ 3000 RPM
U6501	6	4½	5¼	501	178 @ 2600 RPM
R6513	6	4½	5⅛	513	180 @ 2800 RPM
R6572	6	4¼	5⅛	572	200 @ 2800 RPM
R6602	6	4⅜	5⅛	602	212 @ 2800 RPM
S6749	6	5⅛	5½	749	250 @ 2800 RPM
S6820	6	5⅛	5½	820	275 @ 2800 RPM

TRANSPORTATION DIESEL ENGINES

Model	Cyl.	Bore	Stroke	Displ.	Bare Engine H.P.
TD6427	6	4 5/16	4⅛	427	116 @ 2400 RPM
RD6572	6	4¼	5⅛	572	162 @ 2400 RPM
SD6802	6	5 9/16	5½	802	217 @ 2200 RPM

When you choose a vehicle powered by Continental Red Seal engine, you tap a reservoir of experience unsurpassed in the engine-building field. Continental, and Continental only, delivers the balanced combination of power, economy, dependability and long life resulting from all these features—an array found nowhere else:

Patented individual porting . . . full-length water jacketing with directional coolant flow . . . full-pressure lubrication . . . leakproof water pump . . . patented oil and dust seals . . . sodium-filled positive-rotation exhaust valves, stellite-faced . . . dynamically-counterbalanced crankshaft with Tocco-hardened journals . . . five-ring light alloy pistons with chrome-plated top ring . . . all these, and countless other quality features evolved through the years.

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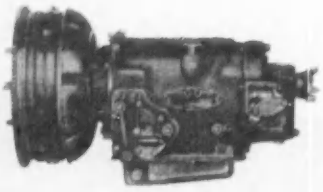
FOR MOST MILES, LOWEST TON-MILE COSTS, AND THE BACKING OF COUNTRYWIDE SERVICE, CHOOSE A MAKE WITH RED SEAL POWER.

Continental Motors Corporation

MUSKEGON, MICHIGAN



designed, engineered and built for

SMOOTH PERFORMANCE

MAXIMUM EFFICIENCY

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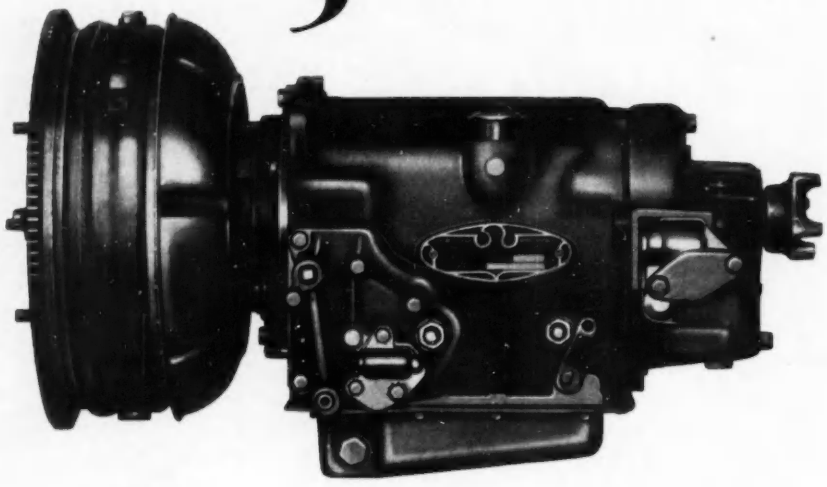

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- **Fast acceleration from standing start—with full utilization of engine power.**
- **Smooth performance in all speed ranges.**
- **Solid direct drive in high—no slippage.**
- **Exceptional rocking ability in snow, mud, slush or sand.**

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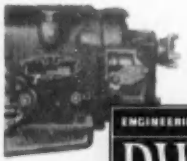

ENGINEERING B-W PRODUCTION

For further information, write, wire or phone

Detroit Gear

DIVISION OF BORG-WARNER CORPORATION • **Detroit 14, Michigan**

Competition closing in on you?

Yes! On you yourself—though the papers are bulging with "Engineers Wanted" ads.

HOW COME?

Your **industry** may already be in a tough competitive market—and some day it certainly **will** be.

Management will be looking to **you** for designs that cut costs and build sales **too.**

so tell management NOW about

"COMPO"® and "POWDIRON"® bearings

(porous bronze) (sintered iron)

Point out how little they cost to **buy**—and **install.**

How they simplify your whole product design.

How they run quietly for years—without any attention at all.

You'll forestall competition for your company—and competition for your job!

You'll find all the facts you need to convince yourself—and your management too—in our bulletins on advantages, applications, installation of these oil-retaining bearings made by Bound Brook powder metallurgy. If you don't have copies of these bulletins, just drop us a line.

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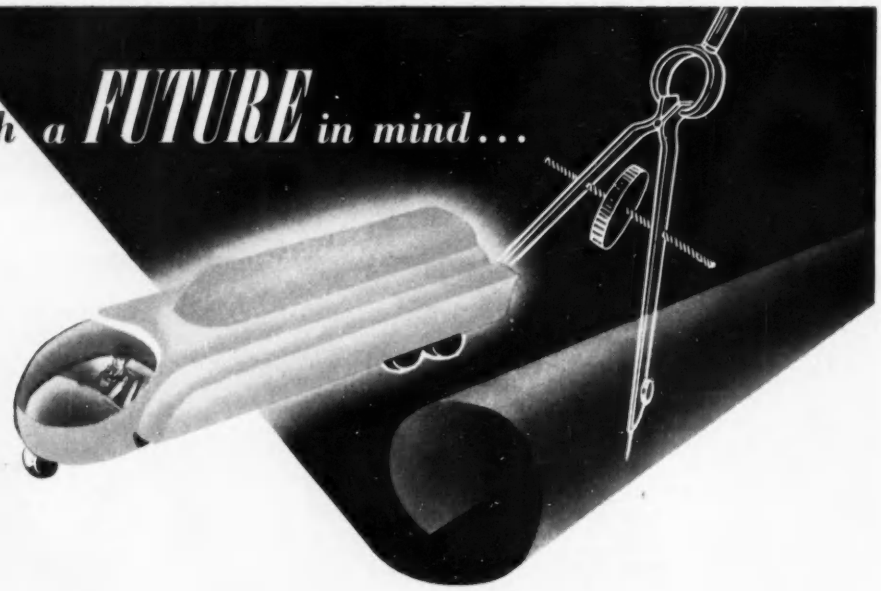
designed with a ***FUTURE*** *in mind...*



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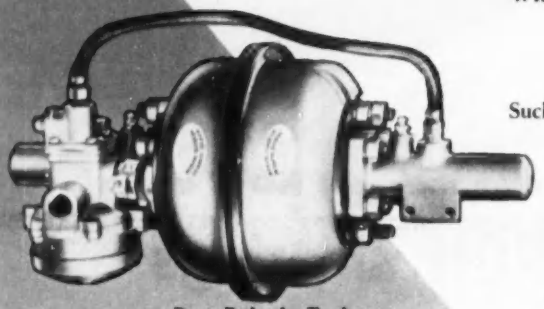
With traffic congestion and highway hazards becoming even more critical as time goes on, automotive products must be geared for the years ahead.

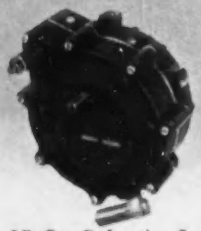
Such is the case with Borg-Warner Power Brakes . . . engineered to fit each vehicle and load requirement. This means *added* protection for both equipment and manpower.

Fleet owners depend on Borg-Warner Power Brakes to meet their braking requirements.

Another example of why "Borg-Warner Equipped" is a magic phrase in the automotive industry!



Power Brakes for Trucks



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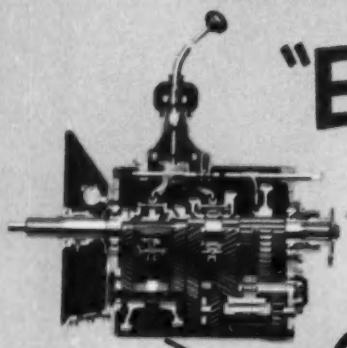
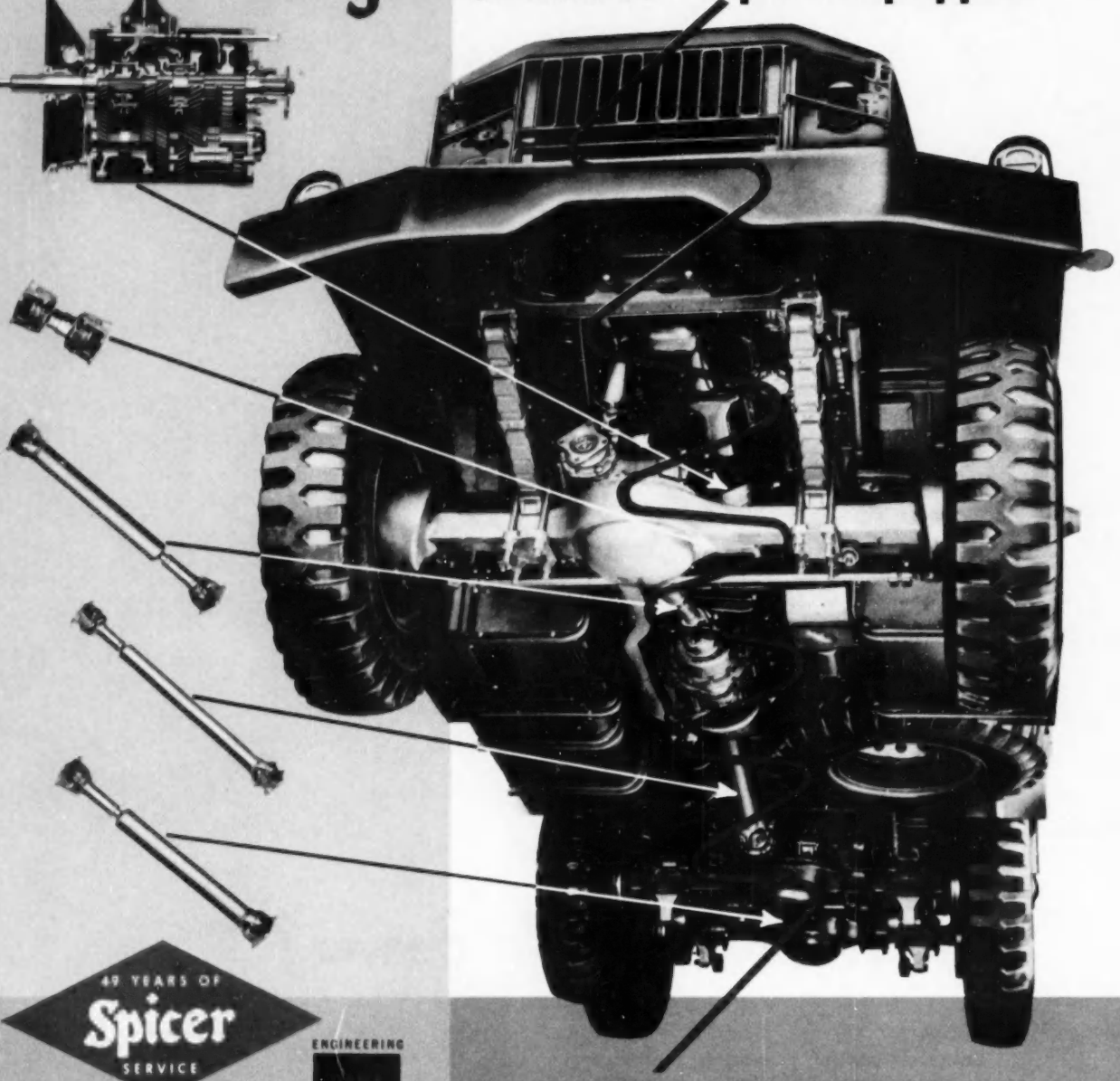
Ambitious amphibious "Eager Beaver"...Spicer-equipped





49 YEARS OF Spicer SERVICE

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... for every type engine

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You can count on

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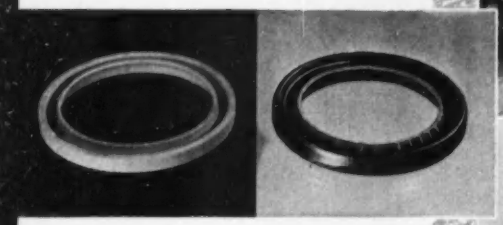
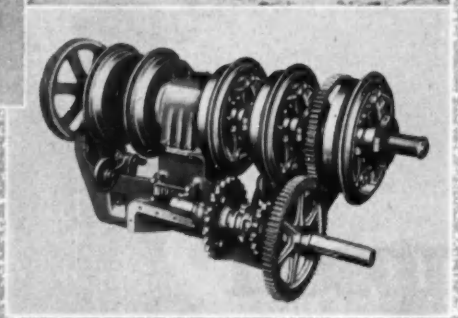




SILASTIC*
Keeps Clutch Shaft Bevel Gears of Lorain TL-25's Bathed in Oil

Silastic lip seals look as good as new after more than 5 years of rugged service on the oil-filled clutch shaft bevel gear housing on the Thew-Lorain model TL power cranes and shovels. Conventional rubber seals failed frequently at operating temperatures in the range of 250°F. Silastic's long service life substantially reduces maintenance costs and production losses.

Performance proves...

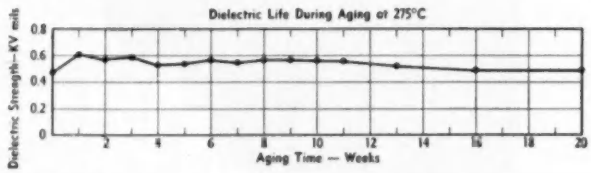
SILASTIC works

where other materials fail!

The turntable is the "guts" of a power crane or shovel, the part that makes the "wheels-go-round", where profit-making performance begins, so it's not surprising that Thew-Lorain put Silastic to work in the TL-25's, their newest idea in turntable design.

Silastic has been performance-proved in thousands of mechanical and electrical applications. It retains its rubbery properties at temperatures ranging from −70 to above 500°F; shows excellent resistance to shock, vibration, oxidation, weathering, and to a wide variety of hot oils and chemicals.

And Silastic stocks for electrical applications are unique even among silicone rubbers for low water absorption and retention of dielectric properties and high physical strength after long aging at Class H temperatures. Proof of the inherent stability of Silastic is given in the graph showing the effect of aging at 275°C (527°F) on the dielectric strength of Silastic.



When you need rubbery properties at temperatures above or below the limits of organic rubbers, or good dielectric properties in a resilient and flexible material, ***specify SILASTIC.***

MAIL COUPON TODAY FOR DATA ON THE PROPERTIES, PERFORMANCE AND APPLICATIONS OF SILASTIC.

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Please send me:

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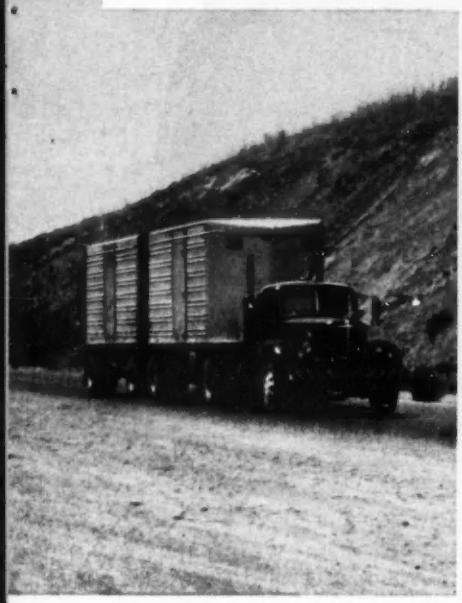
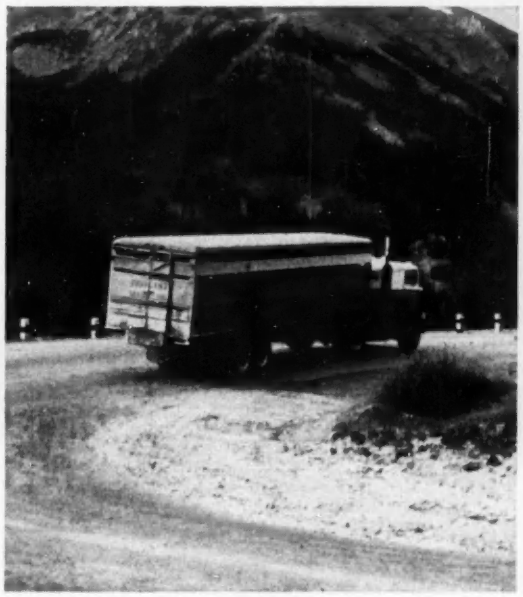
The extra **BRAKING RUGGEDNESS** proven here...





...means

BIGGER MAINTENANCE SAVINGS

on any hauling job!

Why not take a tip for your braking specifications from the men who "roll-em" over the mountains out of Denver, on into California. Here, the rigs are big, the grades are steep—the **braking requirements call for the best . . .** and that means Bendix-Westinghouse Air Brakes! That's because these mighty brakes, built by the industry's most experienced manufacturer, deliver the extra stopping power and performance that assure the **safest, surest, most dependable braking control** and longest service life in the business. And these are factors that mean reliable, economical performance on any hauling job. That's why no matter what type trucks or buses you build, you can **give your customers increased efficiency, plus added savings on maintenance** and parts replacement costs by specifying the brakes proven for long, low-cost operation—Bendix-Westinghouse, the world's most tried and trusted air brakes!

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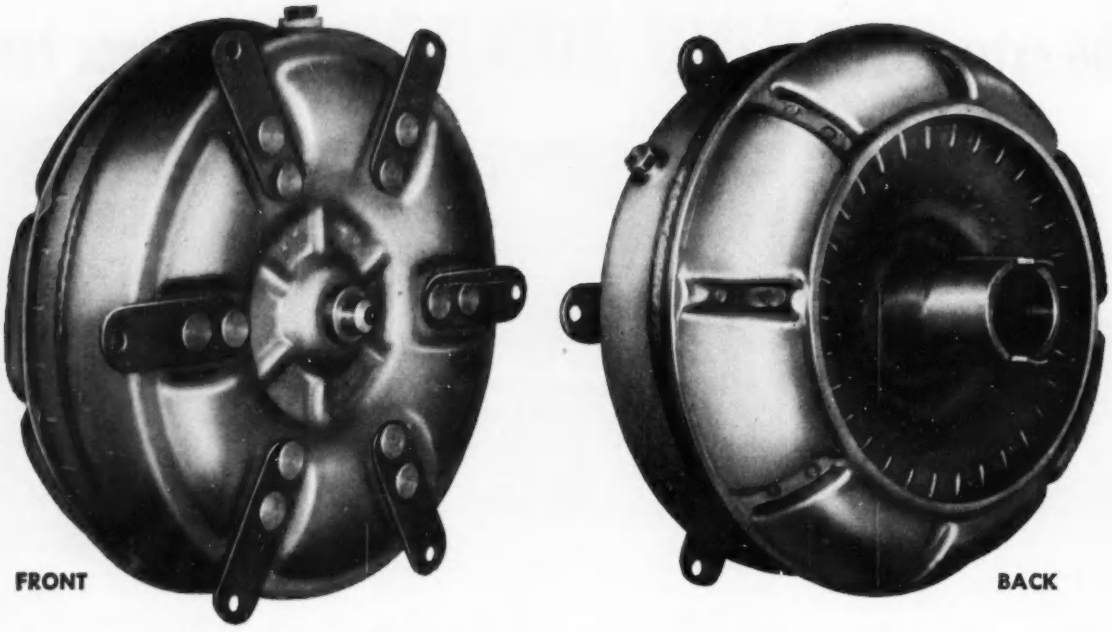

Converter is easily adapted to most power units. Made almost entirely from stampings for low-cost production.

Welded for strength, with leak-proof construction. Designed for direct air-cooling, but oil cooler may be added.

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Carburetor Value as though you were Buying rather than Building the Car!

Put yourself in your customer's shoes. *Lasting performance* is vital to him—and it's certain to effect the selection of his *next* car. It is only logical then, to specify components that will insure that characteristic in the engines you build. In carburetors, Stromberg is unique in this respect, for it is a proven fact that Stromberg* Carburetors *last longer*. Take the *long-range* view of carburetor value and you will agree, it's good business to specify Stromberg Carburetors.

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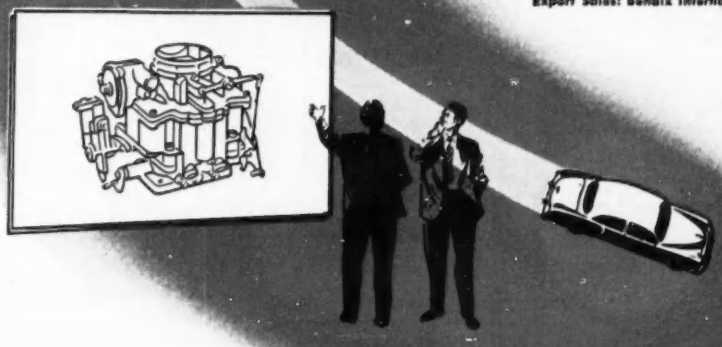

SPICER'S top engineers ALL read SAE Journal

Seated (left to right): R. R. Burkhalter, chief engineer, Universal Joint Division; L. J. O'Brien, chief engineer, Salisbury Axle Works; R. P. Lewis, executive engineer; E. J. Barth, chief engineer, Mechanical Transmissions Division; S. L. Widrig, chief metallurgical engineer; W. V. Thelander, chief engineer, Clutch Division; Standing (left to right): W. P. Michell, chief development engineer; E. W. Zingsheim, chief engineer, Hydraulic Transmission Division; G. L. Tarbox, chief test engineer; A. H. Deimel, chief research engineer.

These men regularly get ideas and facts from SAE Journal . . . And so do their counterparts in more than 5000 other automotive and aeronautic factories. (SAE Journal circulation now exceeds 20,000.)

In automobile and truck companies, in plants which make airplanes, aircraft powerplants, diesel engines, road machinery, farm machinery, parts and accessories . . . everywhere that top-flight automotive engineers gather to make technical decisions, SAE Journal readers are likely to be a majority of those present.

SAE JOURNAL

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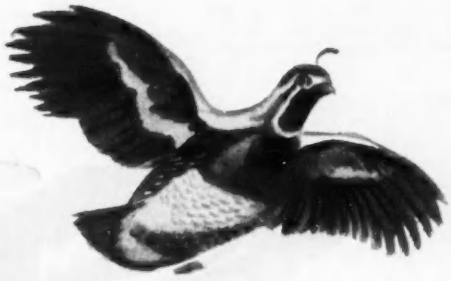
YOU'LL NEVER FIND

a quail in a quandary



The early morning meadow — emerald green and wet with dew . . . snuggled deep in the grass, listening, watching, planning — the hunter's tread sounding closer. Then . . . timing precise, they're racing the wind, a haze of brown and white.

Before you fly into the building of a new product, it's smart to take the time to *plan ahead*. For planning lets you guide your moves — gives you a chance to check the advantages of castings over hard-to-work parts. Campbell, Wyant and Cannon, pioneers in metallurgical engineering, precision control and mechanized production, helps put your product out front. Castings by CWC allow you new and greater design flexibility. They wear *longer*, machine *easier* and . . . they do it all at lower cost.

Let CWC come in and help you bag a better product. It may give you the time to head for the fields and try for the limit.

CAMPBELL, WYANT AND CANNON
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CWC

Since 1908

BEST... again and again!

A leading Diesel manufacturer reports:

We were getting bearing failure in 100 hours ...until we standardized on

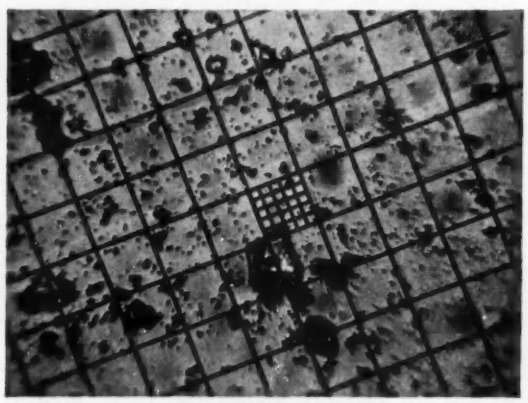
PUROLATOR

FULL-FLOW

MICRONIC FILTERS

IN SERVICE SO SEVERE that engine bearings formerly failed in a hundred hours or less—the same Diesel equipment now operates more than a thousand hours with no visible bearing wear!

This enormous increase in bearing life—this Diesel manufacturer reports—can be credited entirely to Purolator Full-Flow Micronic* filtration. Needless to say, Purolators are now standard equipment on *all* this manufacturer's Diesel vehicles and industrial engines!



The Purolator* Micronic element traps dirt down to *submicrons* in size, and has many times more *dirt storage space* than old-style filters.

Not once . . . not twice . . . but *every time* Purolators have been tested by the world's largest and most important makers of internal combustion engines—Purolators have won top honors. No other filter is capable of delivering the high flow rates necessary for filtering *all* the oil at *each* pass—full-flow filtration—with minimum pressure drop throughout a lengthy service life. And no other filter gives dependable filtration down to *submicrons* (.0000039 in.)! The Micronic element has *ten times* the effective filtering area of old-style filters. And—size for size—no other filter provides as much *dirt storage space* as does Purolator.

Want to prove Purolator's outstanding superiority to your own satisfaction . . . on your own equipment . . . in your own way? Our Engineering Department will gladly co-operate in helping you conduct any type of comparative filter test you may prefer. Simply write, describing your equipment. *Reg. U.S. Pat. Off.

PUROLATOR PRODUCTS, INC.
Rahway, New Jersey and Toronto, Ontario, Canada
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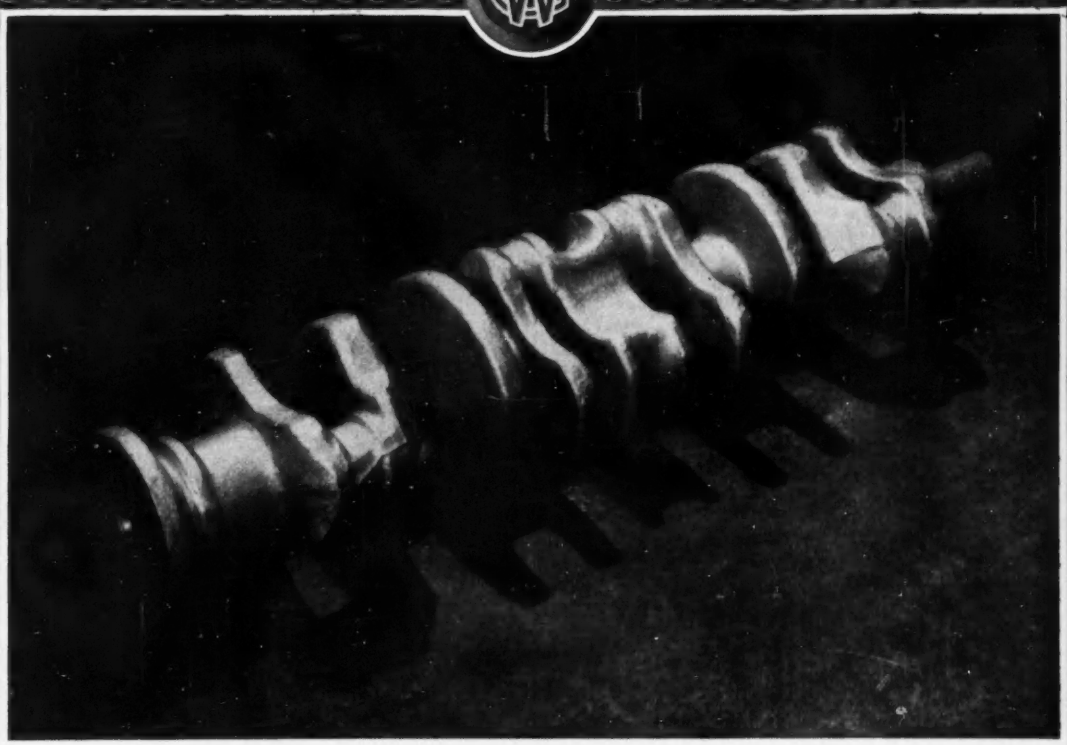
PUROLATOR
MICRONIC OIL FILTER
"FIRST IN THE FIELD OF FILTERING"



Fully counterbalanced crankshaft—the ultimate in modern forging technique . . . Wyman-Gordon . . . crankshaft forging specialists since the introduction of the internal combustion engine . . . first to forge crankshafts with integrally forged counterweights . . . . . .

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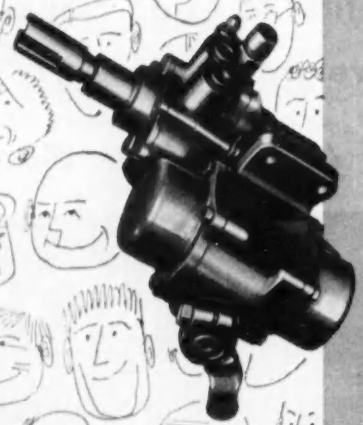

"HYDRAGUIDE"—The only full time hydraulic power steering, has achieved overwhelming popularity with automobile owners, because it provides new, unique pleasure in driving.

The heaviest cars steer with feathertouch ease, yet road feel is ample for safe, comfortable driving. Fully self righting, "HYDRAGUIDE" also prevents swerving from blowouts, soft shoulders, obstructions, etc. Steering effort is reduced by 80% at all times.

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• • • the One Versatile Tool Designed for High Speed, Precision Cutting of Internal Grooves in Housings and Bores

Here is the most complete catalog ever published — on the cutting of internal concentric recesses. Complete with descriptive, illustrated information and data charts showing how the Waldes Truarc Grooving Tool can solve virtually every internal grooving problem you may have. Shows how even *unskilled labor* can perform precise, production-line operations.

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- Charts describing various cutters: single, multiple, beveled and special profiles. Description of bottom adaptors, elongated spindles, and extended bushings . . . for solving particular problems.
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MADE BY THE MANUFACTURERS OF WALDES TRUARC RETAINING RINGS.

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Please send me your new 20-page Catalog on the Waldes Truarc Internal Grooving Tool.

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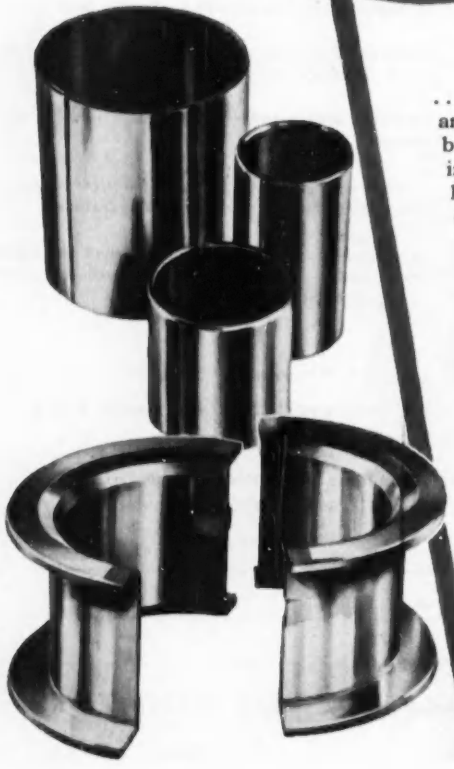
JOHNSON MODERNIZED SLEEVE BEARINGS SOLVE MANY SPECIFIC PROBLEMS



The sleeve bearing is basic in principle . . . for most applications man's genius has never invented any device to replace it. For instance, every internal combustion engine is dependent on it, and the majority of industrial equipment is, too. But modern requirements, high speeds, higher loads, and changing designs have called for new sleeve bearings. Johnson Bronze, alert to the demands of new engineering trends, is producing Johnson Modernized Sleeve Bearings, capable of giving the utmost service under these modern conditions. Aluminum bonded to steel is one of them. Copper-lead bronze-on-steel is another. New materials, new combinations of materials and new designs are meeting many new requirements. If you have a specific sleeve bearing problem, perhaps a Johnson engineer can help you. Write for an appointment.

JOHNSON BRONZE COMPANY
675 South Mill Street, New Castle, Pa.

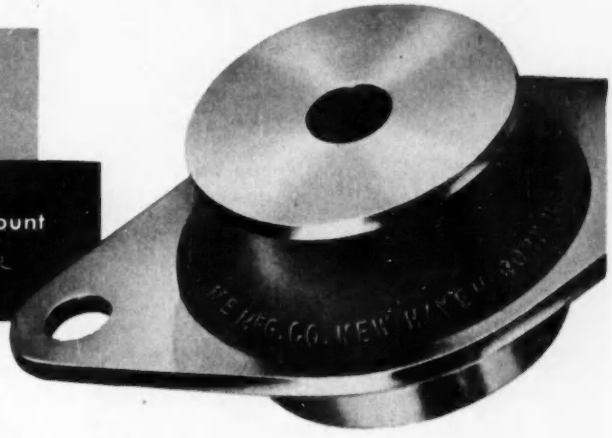
JOHNSON JB BEARINGS
Sleeve-Type

JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS: ALUMINUM-ON-STEEL • CAST ALUMINUM ALLOY • BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited • LEDALOYL powder metallurgy

Vibration Engineering that solves your problems

PROBLEM: To provide superior vibration control while simplifying suspension design

SOLUTION: The Isomode* Type 5 Mount that isolates all modes of motion



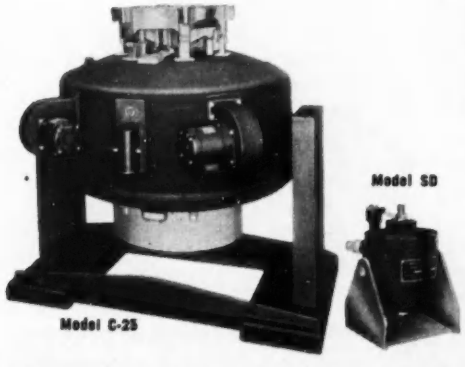
HOW to get optimum isolation into a product design? The answer is not always easy. But it was made much easier to find when Isomode Mounts were developed. They offer what's needed for outstanding results—namely, control of horizontal and rocking motions as well as vertical vibrations.

And here's why. Isomode Mounts have equal spring rates in all directions. They therefore absorb vibrations from all directions equally well. As a result, they can be mounted at any angle, permitting location of ideal suspension points and simplifying design.

In addition, Isomode Mounts have high load capacity in compact size, saving both space and weight. Large rubber volume for their size lends softness for good isolation, yet the mounts are stable, self snubbing and long lasting.

These mounts are an example of the kind of vibration engineering put to work for you at MB. Many companies have found it good practice to make MB their headquarters for vibration information. You will too—on vibration *isolation, control, testing, detection* or *measurement*. For more details on Isomode Mounts, be sure to write for Bulletin 410-7.

*Trade Mark Reg. U.S. Pat. Off.



A vibration exciter to meet your needs

Whether your shake testing requirements are of large order or small, there's an MB Shaker for the job. Model SD, for example, has rated force output of 10 pounds; while the C-25 provides 2500 pounds. Model also available for 10,000 pounds. So if you have to vibration test to MIL-E-5272, be sure to check up with MB. Bulletin No. 1-VE-7 gives technical data on MB Shakers. Write for it.

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PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO REPRODUCE IT

Where hp *really* goes to work!

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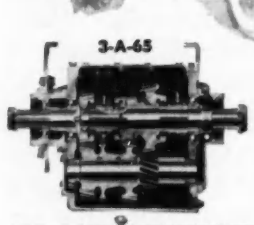
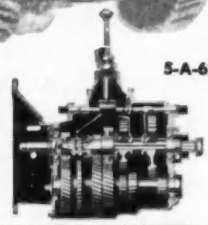
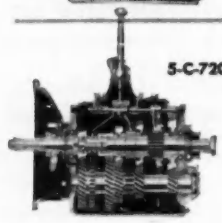
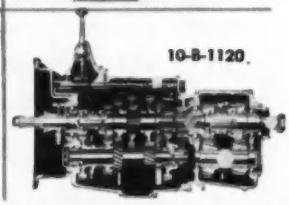
There's a Fuller unit or auxiliary transmission for any application—from two tons to the biggest —to provide exactly the *right gear ratios* for your job—to help your driver keep the engine turning at its most effective speed . . . to assure faster trips —higher average speeds.

That's why you see the Fuller name plate on the gear boxes of more and more trucks and industrial machines. Demand transmissions from the *Fuller* line to get maximum performance from *your* rigs.









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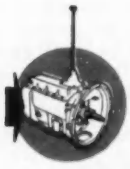

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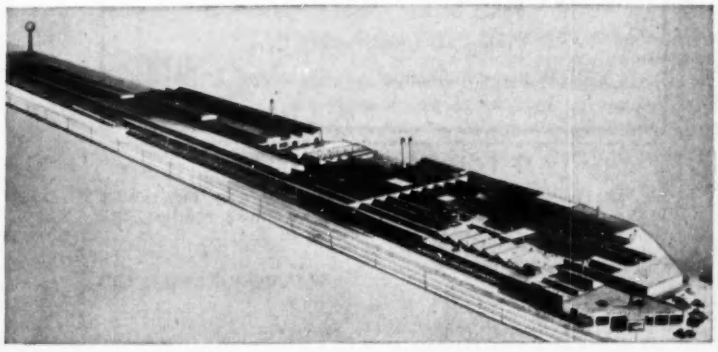

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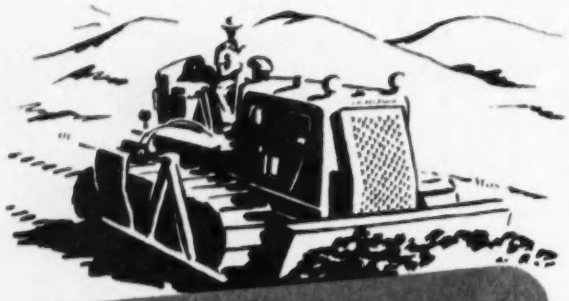

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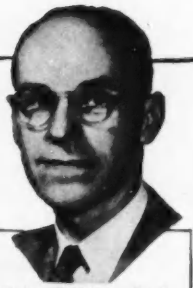

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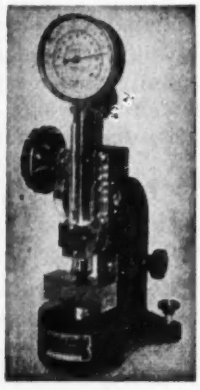

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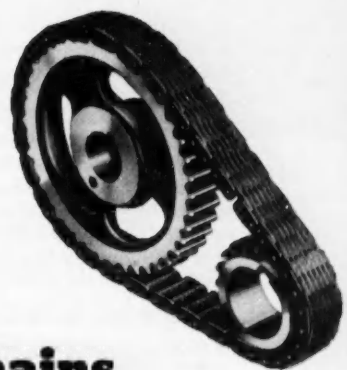

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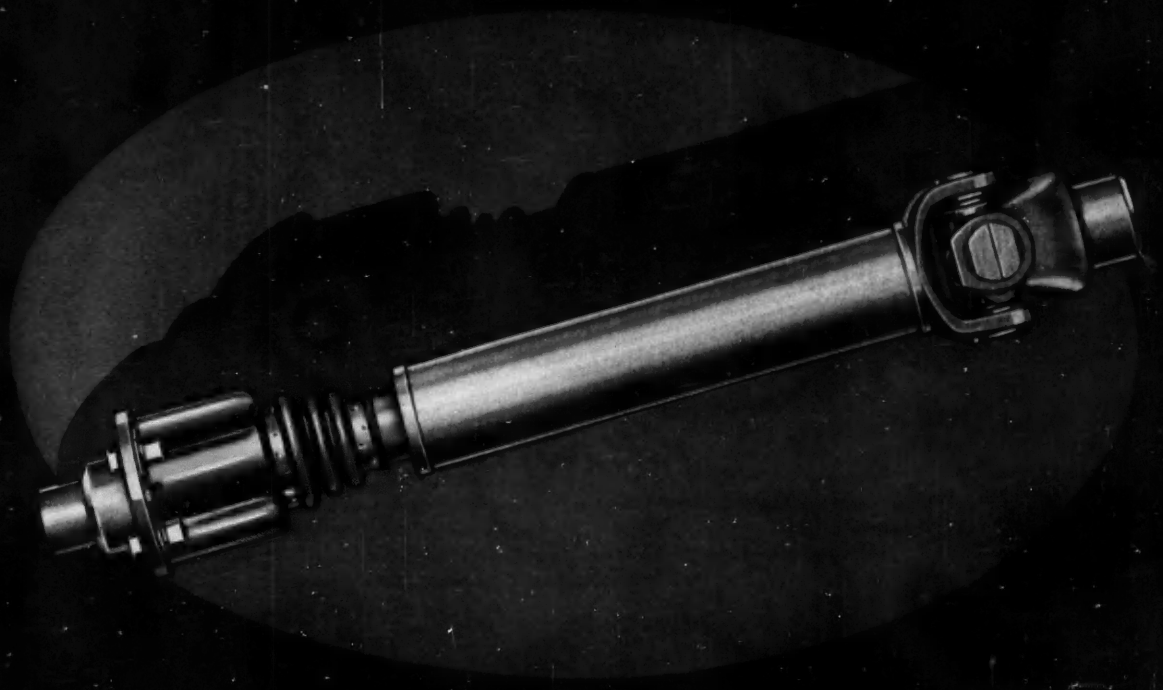

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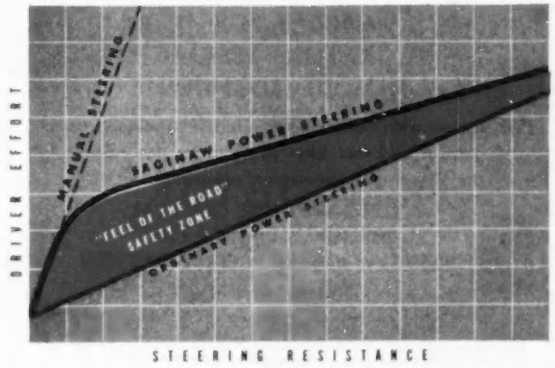

This simplified graph shows the basic difference between Saginaw Power Steering and ordinary types. The latter apply power at the slightest touch of the wheel, tending to cause over-control. Saginaw Power Steering goes into action only when more than "fingertip" pull is needed. This SAFETY ZONE is purposely provided to assure normal "feel of the road" and prevent over-steering.

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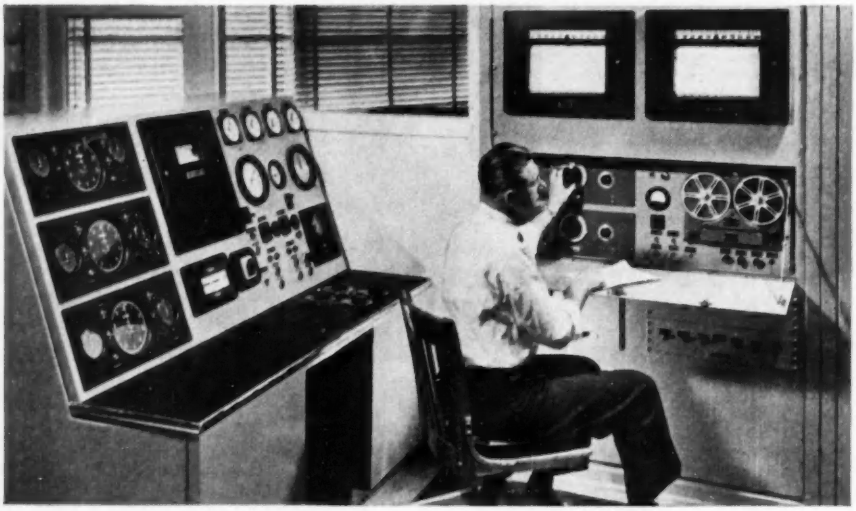

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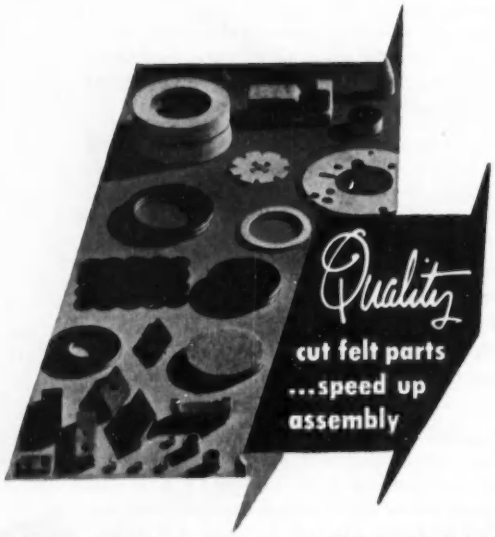

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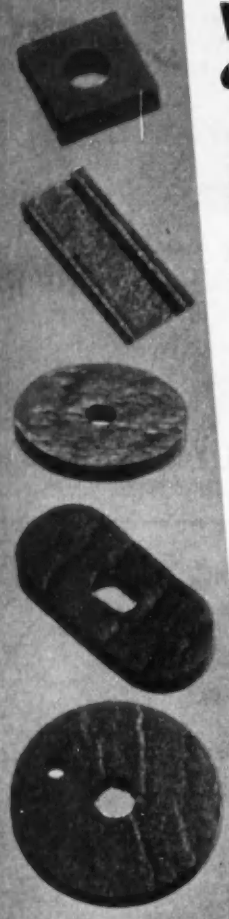

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Here's a *multiple-piece* oil control piston ring that offers all the handling and installation speed and ease of a *one-piece* ring. It's Muskegon's *new*, exclusive "UNITIZED" piston ring with rails and spacer . . . pre-assembled . . . and BONDED TOGETHER!

You can dangle it from your finger—the components will *not* separate—not until the ring is in the engine!

Think of the time-saving benefits for both Production line and Service Shop installation.

Because it's "unitized," there's no fumbling with the components—it can be inserted like a one-piece ring, it's always *correctly* assembled assuring *right* order, and it can be compressed like a one-piece ring! Yes, sir! Whether it's handling or installation, nothing can equal the time-saving and convenience advantages of this ring.

Thoroughly field proven, the Muskegon "UNITIZED" Steel Oil Control Piston Ring is expected to become the choice of leading engine builders!

Our engineers will be happy to counsel with you. Write today. Muskegon Piston Ring Co., Muskegon, Michigan.

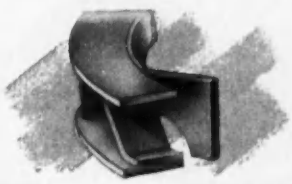
BONDING AGENT DISAPPEARS DURING ENGINE RUN

Muskegon uses a special, bonding adhesive that dissolves completely in the hot engine oil during the first engine run. The pieces are then free to perform as they should.

AVAILABLE WITH OR WITHOUT CHROME

CSR-200 with fully chrome plated edges assuring *double to triple ring life*. Self cleaning and non-clogging design.

CSR-100 without chrome edges. Quick seating—reduces drag to minimum—spacer well vented for free oil flow.



Muskegon "UNITIZED" Oil Control Ring consists of: spacer, two rails and heavy duty expander.

MUSKEGON Piston Rings

MUSKEGON PISTON RING CO.
MUSKEGON, MICHIGAN
PLANTS AT MUSKEGON AND SPARTA

DETROIT OFFICE: 521 New Center Bldg.
Telephone Trinity 2-2113

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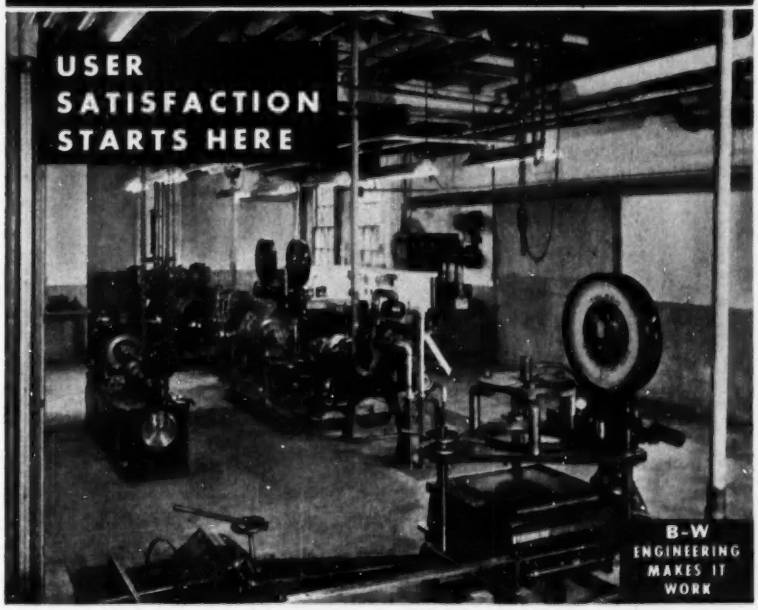
ROCKFORD CLUTCHES

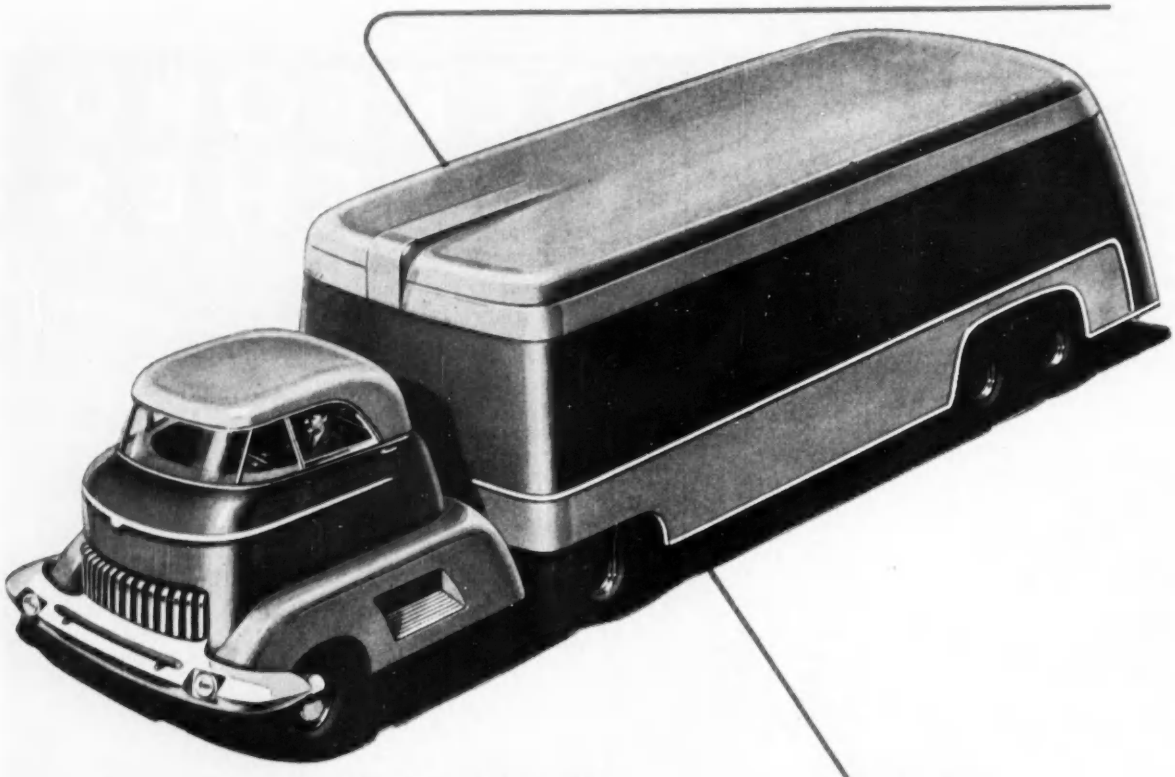


Every type and size ROCKFORD CLUTCH must pass torque, strength, pressure, spin, heat, balance, wear, deflection, friction, run-out, flatness and endurance tests before being put into production. These torture tests are made on specially designed, accurate, clutch-checking machines. Let our engineers give *your* products the benefit of ROCKFORD test-proved CLUTCH reliability.

B-W PRODUCTION MAKES IT AVAILABLE

ROCKFORD CLUTCH DIVISION BORG-WARNER
316 Catherine Street, Rockford, Illinois, U.S.A.

Specify N·A·X HIGH-TENSILE STEEL for Lighter Weight, Longer Life and Operating Economy



N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values at normal and sub-zero temperatures, and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than can mild carbon steel.

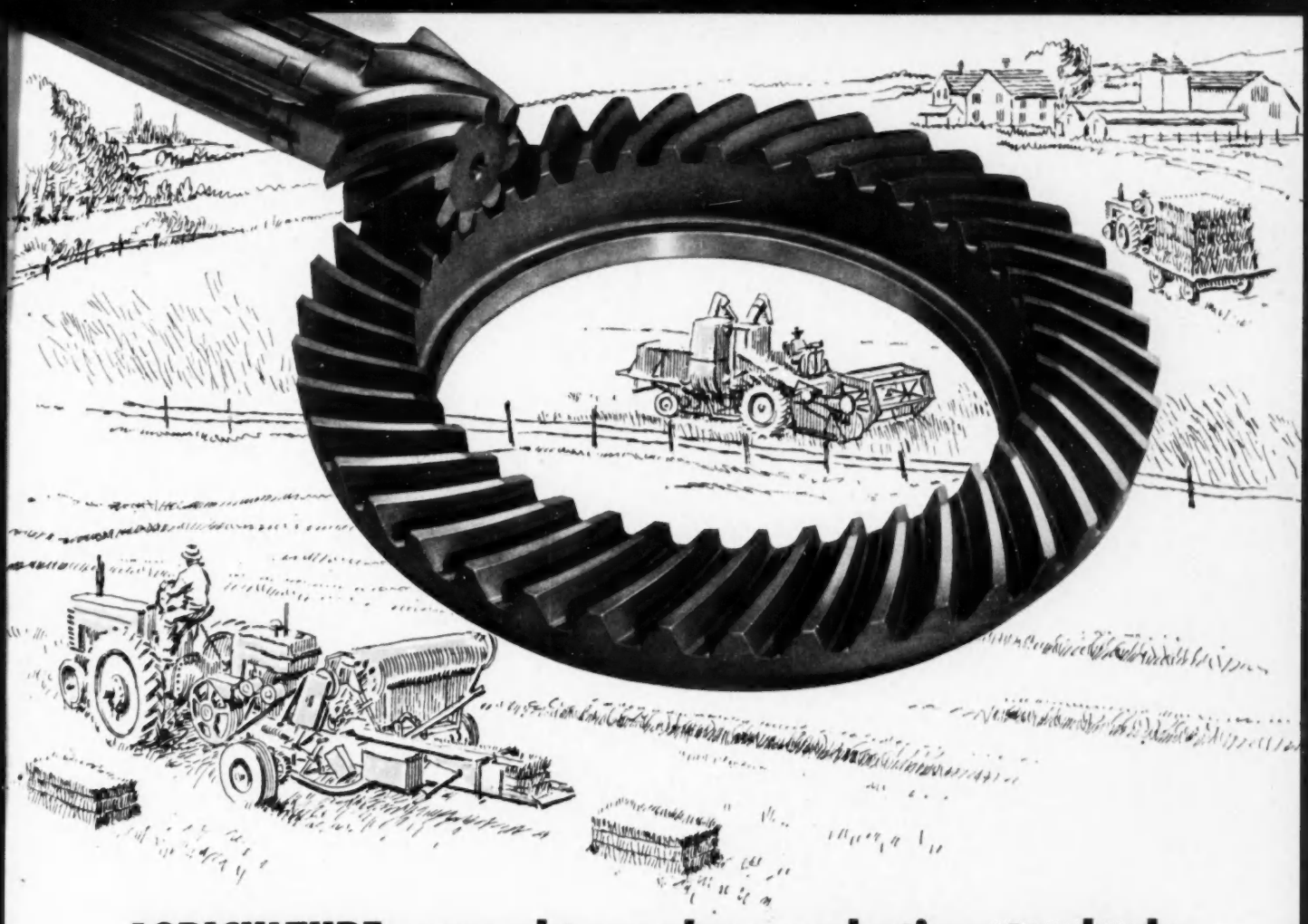
Savings in vehicle weight, with no loss in structural strength, increase the payload ratio and give greater operating economy when you make it a point to specify N-A-X HIGH-TENSILE steel for your highway equipment.

KEEP YOUR SCRAP MOVING TO YOUR DEALER

MAKE A TON OF SHEET STEEL GO FARTHER Specify— N·A·X ... And "MAKE YOUR PRODUCT LAST LONGER"

GREAT LAKES STEEL CORPORATION
N-A-X Alloy Division Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION



AGRICULTURE—geared to modern production standards

A self-propelled combine, handled by one man, will work rings around the old-fashioned threshing crews of a few years ago. And a modern hay-baler does in a few hours, at a single operation, the tedious work that required days of work not long ago. That's modern production—just as efficient—just as important to the nation's good—as the miracles of America's great industries.

We're particularly aware of this development because "Double Diamond" Gears have grown up with the flourishing farm machinery business. For years "Double Diamonds" have been transmitting power in all kinds of mechanized farm equipment. As the machines grew bigger—as demands of them became more critical—"Double Diamond" Gears have grown in demand. They must stand unusual abuse—long periods of idleness followed by around-the-clock service months on end—and must deliver dependable performance at points many miles from service centers. The fact that "Double Diamonds" have met these requirements, and for so many years, makes them a name to bear in mind when your needs call for gears of that character.

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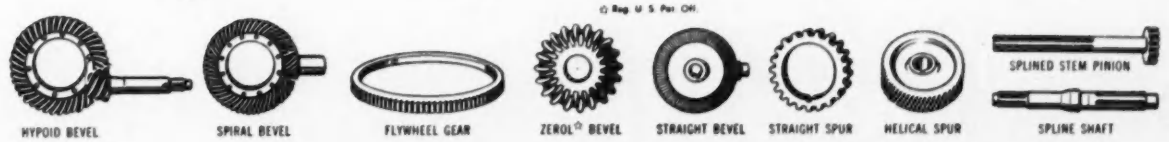
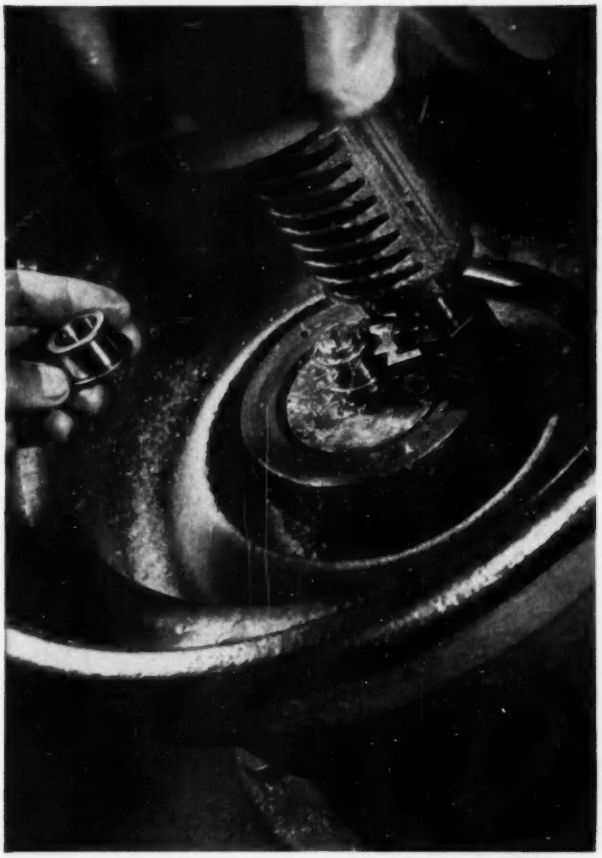


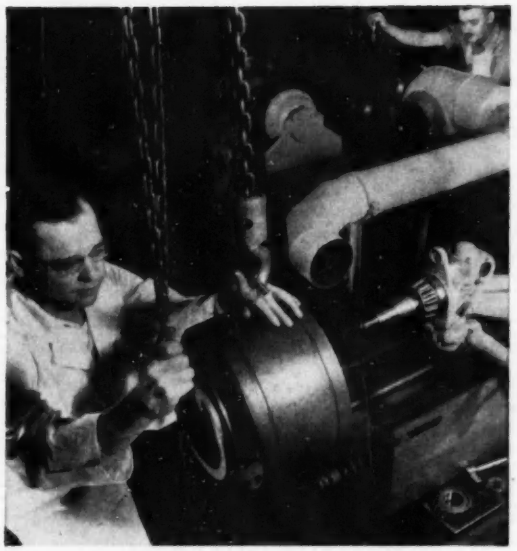
HYPOID BEVEL · SPIRAL BEVEL · FLYWHEEL GEAR · ZEROL☆ BEVEL · STRAIGHT BEVEL · STRAIGHT SPUR · HELICAL SPUR · SPLINE SHAFT

THIS NUMBER SAYS A MOUTHFUL. HM89446—HM89410 tells the dimensions of a certain tapered roller bearing, often used in pinions. Quite a lot for a number to say. But when it's a *Timken* bearing number, it tells some *extra* tales of quality and service . . .

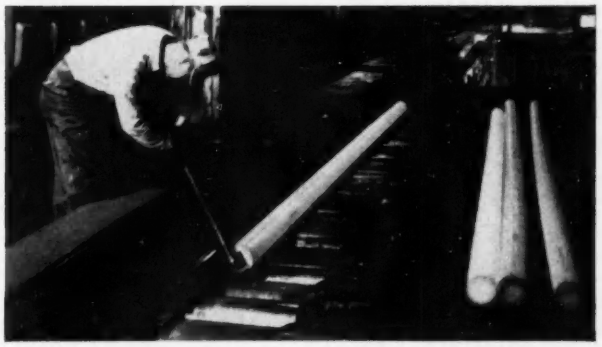
Look what you can say with numbers



AN EXTRA STEP that goes into the making of every Timken® bearing: honing the races to a super smoothness. The result shows up in the moving parts of your car . . . the vital zone. On pinions, for example, the super-finish helps Timken bearings maintain their original setting. Gears run quieter and last longer.



THIS EXTRA SERVICE paid off for one well-known axle manufacturer. Using his front axle in our physical laboratory we ran bearings under simulated maximum driving loads. Result: Timken Company engineers were able to show the manufacturer how to get longer bearing life.



AN EXTRA PRECAUTION taken by the Timken Company is the making of its own steel. No other bearing company does this. Above, a billet is stamped to identify the heat and ingot it came from, assuring closer quality control. Don't just specify a bearing number. Specify "Timken" too. And for *full* value, use a Timken bearing cup with a Timken bearing cone. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN is number 1 for VALUE where value counts most: in the vital zone

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓡ AND THRUST →ⓣ← LOADS OR ANY COMBINATION →✳←